

Status – Hall C

- Hall C in full operation for ~four years.
- Fourteen collaborations have conducted experiments to date.
 - 17 Ph.D.'s already awarded out of 34 graduate students who took their data from 96 – 99.
 - 8 publications to date
- Five “standard configuration” experiments completed in 99.
- Four “large scale” exps. scheduled to run 00–02.
 - HNSS (Tang/Hungerford)
 - G_E^n (Madey/Kowalski)
 - G_E^n via $\vec{D}(\vec{e}, e'n)$ (Day/Mitchell)
 - G^0 Parity Violation

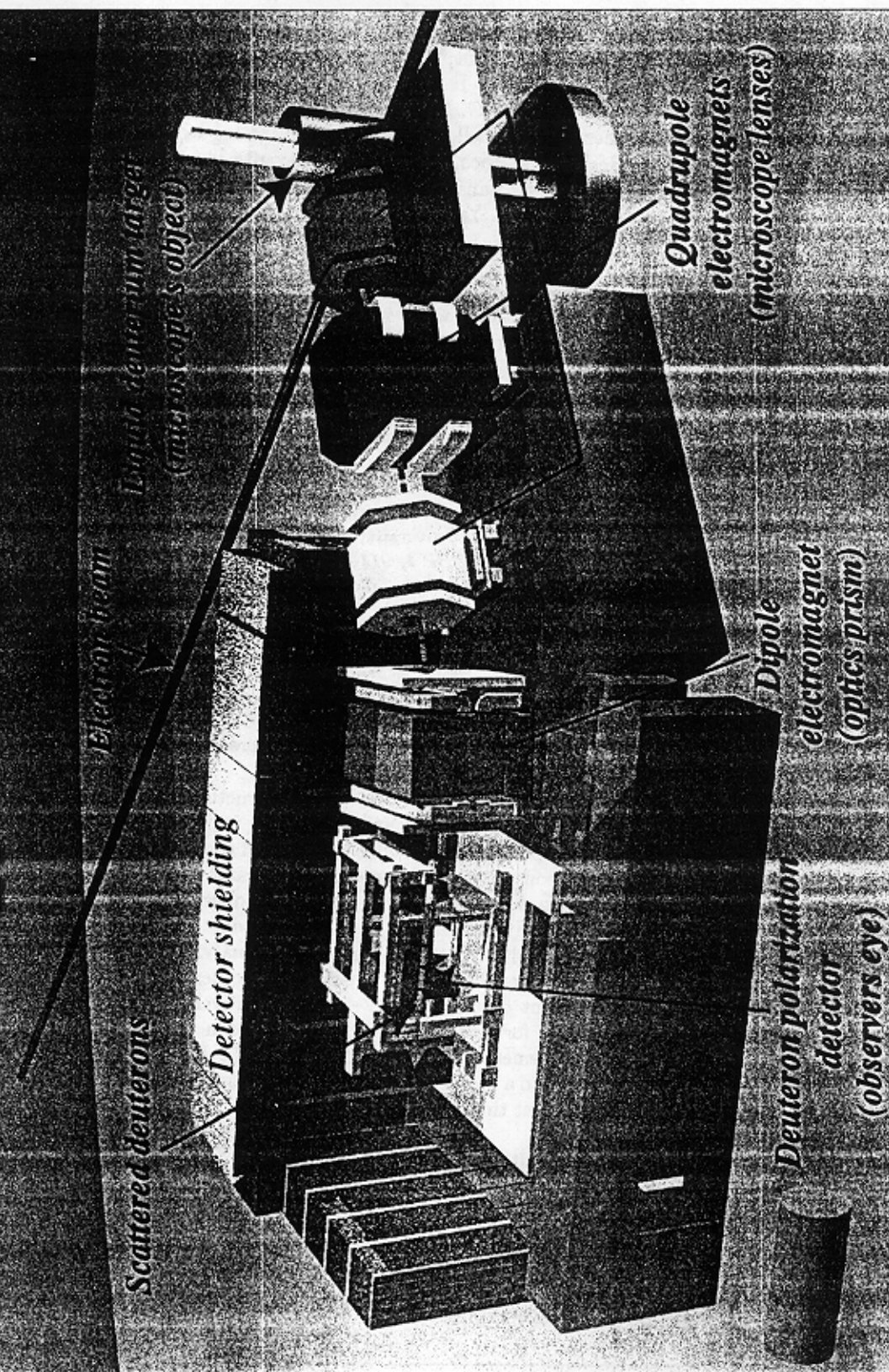
HALL C - Completed Experiments

<u>Title</u>	<u>Experiment</u>	<u>Spokesperson</u>	<u>Status</u>	<u>Graduate Students</u>	<u>Ph.D.'s Awarded</u>
Energy Dependence of N Propagation in Nuclei in (e,e'p)	E-91-013	D. Geesaman	pub. (1), sub. (1)	2	2
Photodisintegration of the Deuteron at 1.5 - 4 GeV	E-89-012	R. J. Holt	published (2)	3	3
Inclusive Scattering from Nuclei at $x > 1$ and High Q ²	E-89-008	B. Filippone	published	3	1
Electroproduction of Kaons and Light Hypernuclei	E-91-016 (A)	B. Zeldman	draft	4	1
L/T Separation in p(e,e'K ⁺)	E-93-018	O. K. Baker	pub. (1), sub. (2)	3	3
Δ (1232) Form Factor at High Momentum Transfer	E-94-014	J. Napolitano	published (2)	2	2
T_{20} from D(e,e'd)	E-94-018	S. Kox/E. Balse	pub. (1), draft (1)	6	5
Charged Pion Form Factor	E-93-021	D. Mack	analysis	2	
Pion Electroproduction in 2D, 3He, and 4He	E-91-003	H. Jackson	analysis	2	
The Charge Form Factor of the Neutron	E-83-026 (A)	D. Day	analysis	2	
Two-Body Photodisintegration of Deuteron at High Energy	E-98-003	R. J. Holt	analysis	1	
Color Transparency	E-91-007	R. Milner	analysis	1	
Measurement of $R = \sigma_L/\sigma_T$ in the Resonance Region	E-94-110	C. Keppel	analysis	1	
Correlated Spectral Function & (e,e'p) Reaction Mechanism	E-97-006	I. Sick	analysis	1	
Electroproduction of Kaons and Light Hypernuclei	E-91-018 (B)	B. Zeldman	analysis	1	
Calendar 2000 Program					
➡ Spin Dependence of ΔN Effective Interaction in P Shell	E-89-009	Hungerford / Tang	run 2000		
Inclusive resonance σ for Parton-Hadron duality studies	E-97-010	C. Keppel	run 2000		
➡ The Electric and Magnetic Form Factors of the Neutron	E-93-038	Madey / Kowalski	run 2000		
Upcoming Large Scale Exp's					
➡ The Charge Form Factor of the Neutron	E-93-026 (B)	Day / Mitchell	run 2001		
➡ G0 Parity Measurement	E-91-017	D. Beck	run 2002		
8 published				34	17

3 submitted
4

new DNP Dissertation Award
John Arvington
x > 1 thesis

t₂₀ Deuteron Channel



3D/Hall/CA20-10 Jan 12/597

Measurement of Tensor Polarization in Elastic Electron-Deuteron Scattering at Large Momentum Transfer

D. Abbott,⁴ A. Ahmidouch,^{6,10} H. Anklin,¹¹ J. Arvieux,^{9,12} J. Ball,^{2,9} S. Beedoe,¹⁰ E.J. Beise,³ L. Bimbot,¹² W. Boeglin,¹¹ H. Breuer,³ R. Carlini,⁴ N.S. Chant,³ S. Danagouliau,^{10,4} K. Dow,⁶ J.-E. Ducret,² J. Dunne,⁴ L. Ewell,³ L. Eyraud,¹ C. Furget,¹ M. Garçon,² R. Gilman,^{4,7} C. Glashauser,⁷ P. Gueye,⁴ K. Gustafsson,³ K. Hafidi,² A. Honegger,⁸ J. Jourdan,⁸ S. Kox,¹ G. Kumbartzki,⁷ L. Lu,¹ A. Lung,³ D. Mack,⁴ P. Markowitz,¹¹ J. McIntyre,⁷ D. Meekins,⁴ F. Merchez,¹ J. Mitchell,⁴ R. Mohring,³ S. Mtingwa,¹⁰ H. Mrktchyan,¹³ D. Pitz,^{2,3,4} L. Qin,⁴ R.D. Ransome,⁷ J.-S. Réal,¹ P.G. Roos,³ P. Rutt,⁷ R. Sawafra,^{10,4} S. Stepanyan,¹³ R. Tieulent,¹ E. Tomasi-Gustafsson,^{2,9} W. Turchinets,⁵ K. Vansyoc,⁴ J. Volmer,⁴ E. Voutier,¹ W. Vulcan,⁴ C. Williamson,⁵ S.A. Wood,⁴ C. Yan,⁴ J. Zhao,⁸ and W. Zhao⁵

(The Jefferson Lab t₂₀ collaboration)

¹ Institut des Sciences Nucléaires, IN2P3-UJF, 38026 Grenoble, France

² DAPNIA/SPHn, CEA/Saclay, 91191 Gif-sur-Yvette, France

³ University of Maryland, College Park, MD 20742, USA

⁴ Thomas Jefferson National Accelerator Facility, Newport News, VA 23606, USA

⁵ M.I.T.-Laboratory for Nuclear Science and Department of Physics, Cambridge, MA 02139, USA

⁶ M.I.T.-Bates Linear Accelerator, Middleton, MA 01949, USA

⁷ Rutgers University, Piscataway, NJ 08855, USA

⁸ Basel Institut für Physik, Switzerland

⁹ LNS-Saclay, 91191 Gif-sur-Yvette, France

¹⁰ North Carolina A. & T. State University, Greensboro, NC 27411, USA

¹¹ Florida International University, Miami, FL 33199, USA

¹² IPNO, IN2P3, BP 1, 91406 Orsay, France

¹³ Yerevan Physics Institute, 375036 Yerevan, Armenia

Tensor polarization observables (t_{20} , t_{21} and t_{22}) have been measured in elastic electron-deuteron scattering for six values of momentum transfer between 0.66 and 1.7 (GeV/c)². The experiment was performed at the Jefferson Laboratory in Hall C using the electron HMS Spectrometer, a specially designed deuteron magnetic channel and the recoil deuteron polarimeter POLDER. The new data determine to much larger Q^2 the deuteron charge form factors G_C and G_Q . They are in good agreement with relativistic calculations and disagree with pQCD predictions.

The development of a quantitative understanding of the structure of the deuteron, the only two-nucleon bound state, has long been considered an important testing ground for models of the nucleon-nucleon potential. Nevertheless, the charge distribution of the deuteron is not well known experimentally, because it is only through the use of both polarization measurements and unpolarized elastic scattering cross sections that it can be unambiguously determined. In the experiment described here, a precise determination of the charge form factor of the deuteron is presented through measurement of the deuteron tensor polarization observables up to a momentum transfer of $Q^2=1.7$ (GeV/c)², for the first time well beyond its zero crossing.

Since the deuteron is a spin-1 nucleus, its electromagnetic structure is described by three form factors: the charge monopole G_C , quadrupole G_Q and magnetic dipole G_M . Thus it is possible to unambiguously separate the three components only through measurement of three observables. In the one-photon exchange approximation, the elastic scattering cross section is typically expressed

in terms of structure functions $A(Q^2)$ and $B(Q^2)$ (see expressions e.g. in [1]) that can be separately determined by variation of the scattered electron angle θ_e for a given momentum transfer Q^2 to the deuteron.

The third observable can be the cross section dependence on deuteron (tensor or vector) polarization. The tensor analyzing powers can be measured using a polarized deuteron target (with unpolarized beam) [2-5]. Alternatively, the tensor moments of the outgoing deuterons can be measured using unpolarized beam and target [6,7]. Both types of experiment result in the same combinations of form factors:

$$t_{20} = -\frac{1}{\sqrt{2}S} \left(\frac{8}{3}\eta G_C G_Q + \frac{8}{9}\eta^2 G_Q^2 + \frac{1}{3}\eta \left[1 + 2(1+\eta) \tan^2 \frac{\theta_e}{2} \right] G_M^2 \right) \quad (1)$$

$$t_{21} = \frac{2}{\sqrt{3}S \cos \frac{\theta_e}{2}} \eta \left[\eta + \eta^2 \sin^2 \frac{\theta_e}{2} \right]^{\frac{1}{2}} G_M G_Q \quad (2)$$

$$t_{22} = -\frac{1}{2\sqrt{3}S} \eta G_M^2, \quad (3)$$

TABLE I. Measured tensor Polarization observables $t_{kq}(\theta_e)$, with statistical and systematic errors. The charge form factors are given, with in some occurrences asymmetric overall errors.

Q^2 (GeV/c) ²	.651	.775	1.009	1.165	1.473	1.717
θ_e (deg.)	35.6	33.4	29.8	27.3	23.0	19.8
t_{20}						
$\pm \Delta_{stat.}$	-546 ± 038	-322 ± 031	191 ± 034	301 ± 048	625 ± 094	477 ± 178
$\pm \Delta_{syst.}$	± 170	± 088	± 043	± 056	± 141	± 063
t_{21}						
$\pm \Delta_{stat.}$	463 ± 051	315 ± 041	201 ± 042	220 ± 056	166 ± 096	-001 ± 152
$\pm \Delta_{syst.}$	± 113	± 083	± 077	± 094	± 056	± 058
t_{22}						
$\pm \Delta_{stat.}$	087 ± 042	-027 ± 030	-018 ± 029	022 ± 035	-023 ± 054	-133 ± 074
$\pm \Delta_{syst.}$	± 037	± 037	± 029	± 037	± 048	± 047
$G_C \times 10^2$	$-120 \pm .162$	$-255 \pm .064$	$-396 \pm .028$	$-345 \pm .031$	$-312 \pm .060$	$-189 \pm .036$
						$-.051$
G_Q	$.399 \pm .007$	$.261 \pm .006$	$.122 \pm .004$	$.079 \pm .003$	$.033 \pm .005$	$.023 \pm .002$
	$-.008$				$-.007$	$-.004$

the right-hand side best reproduced the angular distribution of the polarized efficiency measured in this experiment. A small spin precession correction was then applied, corresponding to a net deviation of 29.7° in the deuteron channel. Our results [14,16–18] are given in Table I. The systematic errors include those due to analysis cuts (mostly from geometrical POLDER cuts), the uncertainties in the deuteron energy (from beam energy, electron angle, beam position on target), the uncertainties in calibration results (statistical and systematic errors on analyzing powers, interpolation, absolute stability on unpolarized efficiency) as well as the small instrumental unphysical asymmetries measured in the calibration. The uncertainty coming from the knowledge of the deuteron energy was larger at the lowest Q^2 point because of the energy dependence of ϵ_0 . In the case of the point at 1.47 (GeV/c)², the θ distribution of ϵ_{pol} did not match exactly the expected behaviour from Eq. 4. This led to the addition of a contribution to the systematic error in t_{20} for this point of $\Delta t_{20}=0.1$. These systematic errors were combined quadratically.

For the sake of comparison with other data and with theoretical models, small corrections (of order B/A and $B \tan^2(\theta_e/2)/A$, see Eqs. 1–3) were applied to calculate t_{2q} at the conventionally accepted angle of 70° . These results obtained for the tensor polarization observables are shown in Fig. 1 and 2, and compared with the existing world data [2–7] and with several recent theoretical predictions [19–23]. The error bars include both statistical and systematic errors, combined quadratically.

Where the new data overlap with the earlier Bates data [7], they agree within the combined uncertainties, although it appears that the Bates t_{20} values are systematically more negative. The indication of t_{21} crossing 0 confirms the existence of a node of the magnetic form factor G_M (see Eq. 2) around 2 (GeV/c)², as first indicated by a measurement of $B(Q^2)$ [12].

A recent non-relativistic impulse approximation prediction (NRIA) [19] calculated using the Argonne v_{18} potential for the NN interaction, seems to reproduce the Bates data (the dotted curve in Fig.1 and 2). But to be in

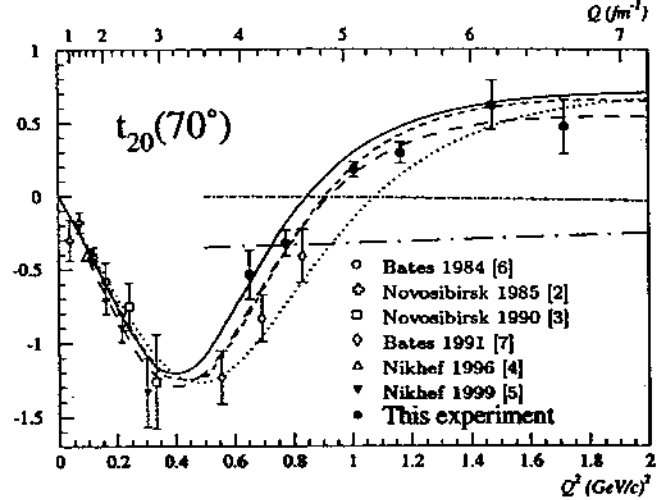
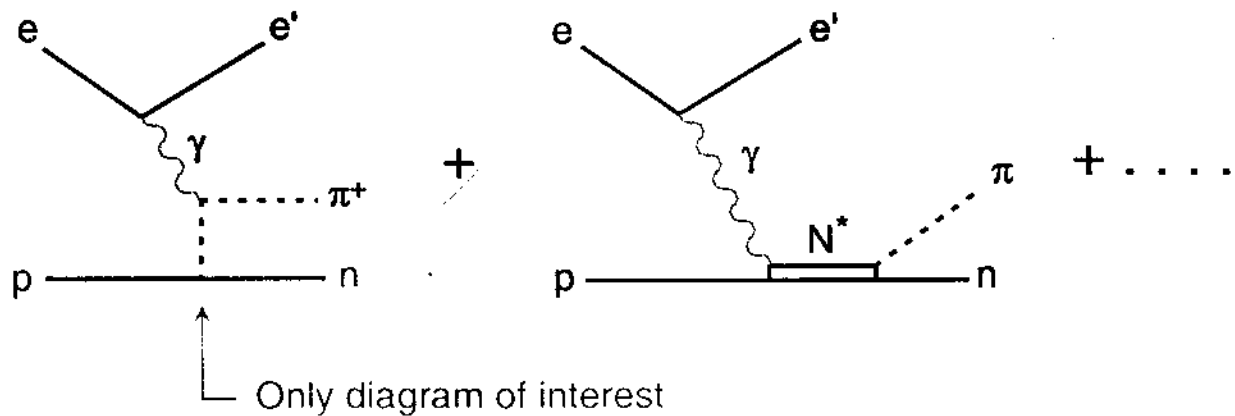


FIG. 1. t_{20} at $\theta_e=70^\circ$ compared to theoretical predictions; dotted line (NRIA) and full line (NRIA+MEC+RC) [19]; relativistic models with dashed line [20] and long dashed line [21]; pQCD calculations with dashed-dotted line [22] and long dashed-dotted line [23].

a reasonable agreement with our new t_{20} data, meson exchange currents (MEC) and relativistic corrections (RC) (solid curve) must be included. The meson exchange current calculation includes pair terms and the $\rho\pi\gamma$ mechanism, for which the strength is not well known [24].

Two relativistic and covariant models, both including MEC, are compared with the data. The dashed curve [20] uses a three-dimensional reduction of the Bethe-Salpeter equation using an equal-time formalism, and includes $\rho\pi\gamma$ exchange currents. The long dashed curve [21] is the prediction of a model developed in the framework of the explicitly covariant version of light front dynamics. It uses a full relativistic potential, calculated with the same set of mesons and parameter values used in the construction of the Bonn potential, but does not include the $\rho\pi\gamma$ MEC. Both models are in good agreement with our t_{20} data, but the prediction based on the light cone formalism agrees better with the last NIKHEF data, at

π - Form factor Measurement from π Electroproduction



Isolate diagram of interest via:

- Longitudinal / transverse separation

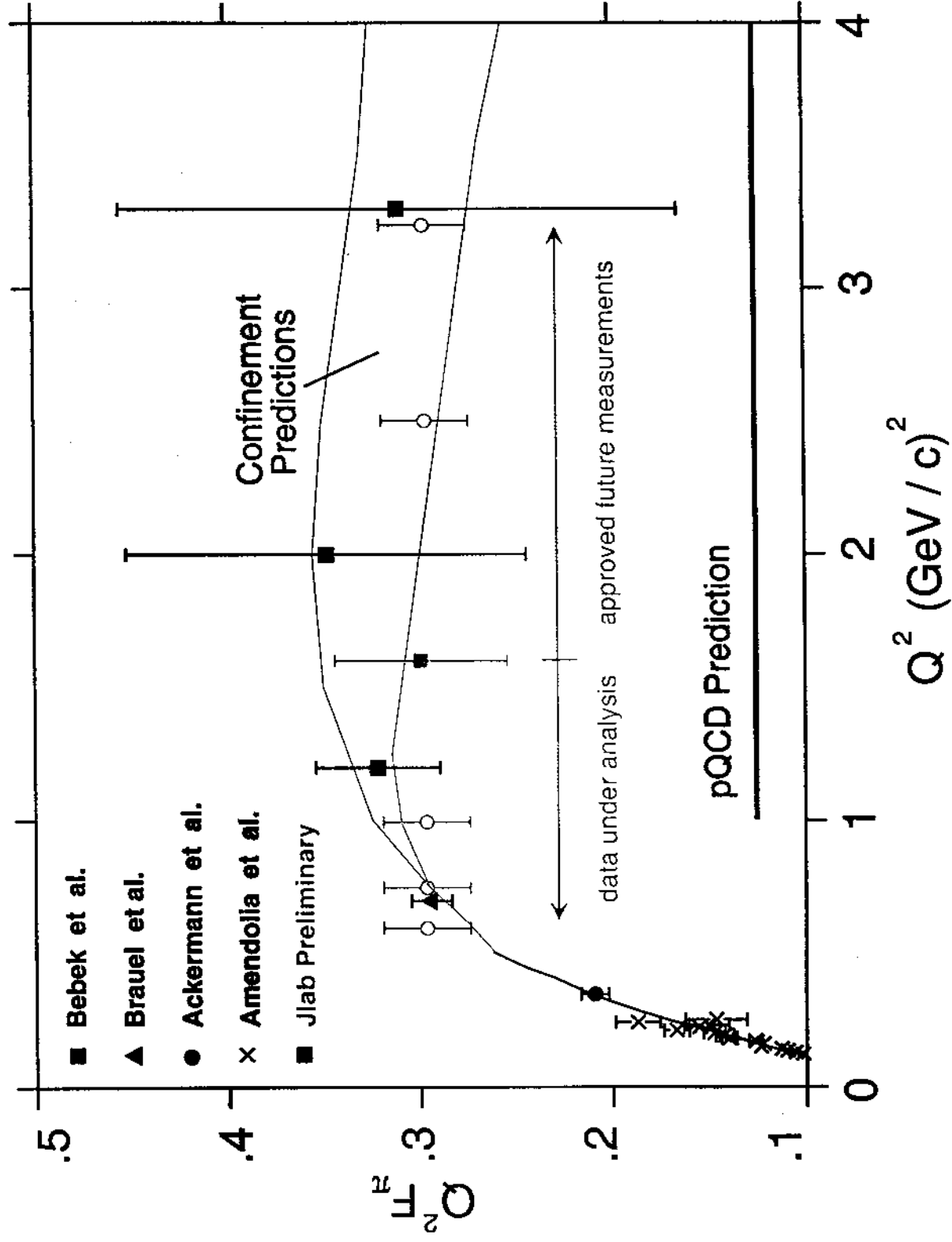
$$\sigma = \sigma_T + \epsilon \sigma_L + \epsilon \cos 2\phi \sigma_{TT} + [2\epsilon(1 + \epsilon)]^{1/2} \cos \phi \sigma_{LT}$$

- Concentrate on small θ_π (small t ; $\theta_{q\pi} \approx 0$)

$$\sigma_L \propto \frac{-2tQ^2}{(t - m_\pi^2)^2} \cdot g^2(t) \cdot F_\pi^2(Q^2)$$

- Extrapolate to π - pole

F_π from $\pi + e$ Elastic and π Electroproduction at High W



Hall C:

Summary of Physics Running in 1999

E96-003: Holt: Photodisintegration of the Deuteron

E91-007: Milner/Ent: Color Transparency

E94-110: Keppel: R in the Nucleon Resonance Region

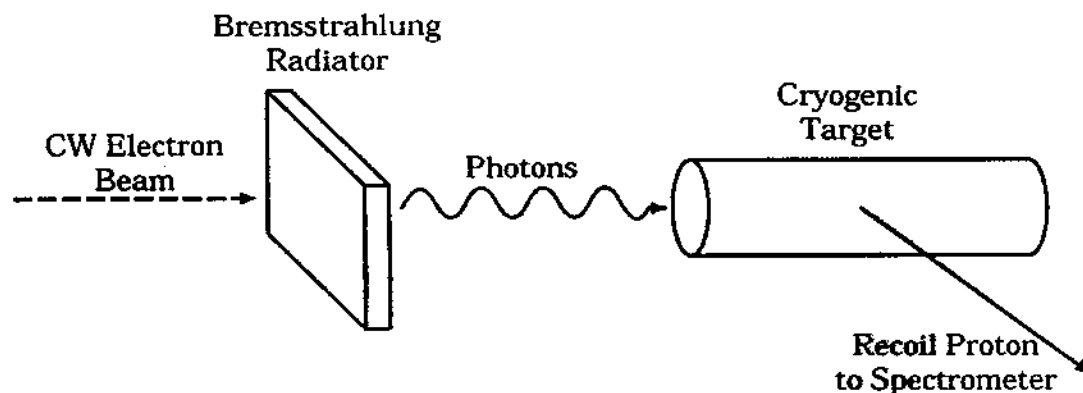
E97-006: Sick: Short Range Correlations

E91-016: Reinhold/Zeidman: Electroproduction of Kaons

E96-003: Two Body Photodisintegration of the Deuteron at High Energy

Continuation of E89-012 ($\leq 4\text{GeV}$) to higher energies
(5 and 5.5 GeV)

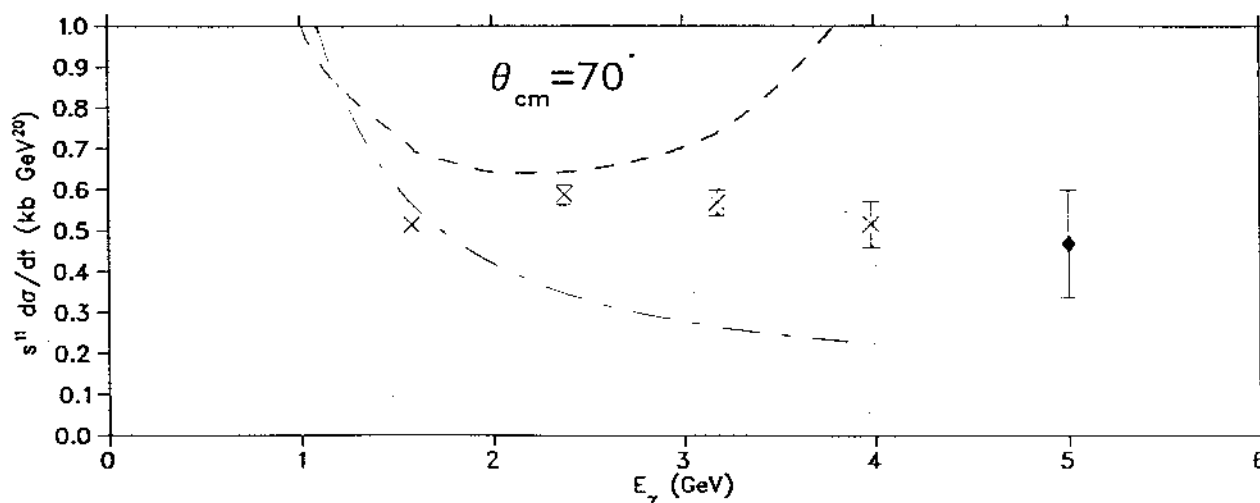
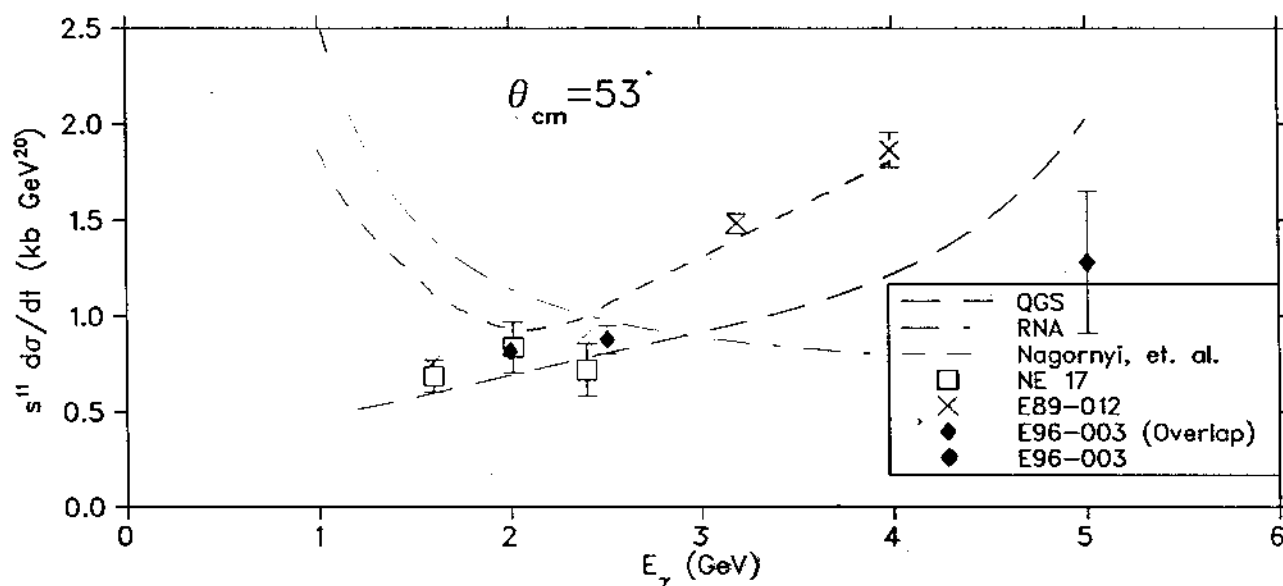
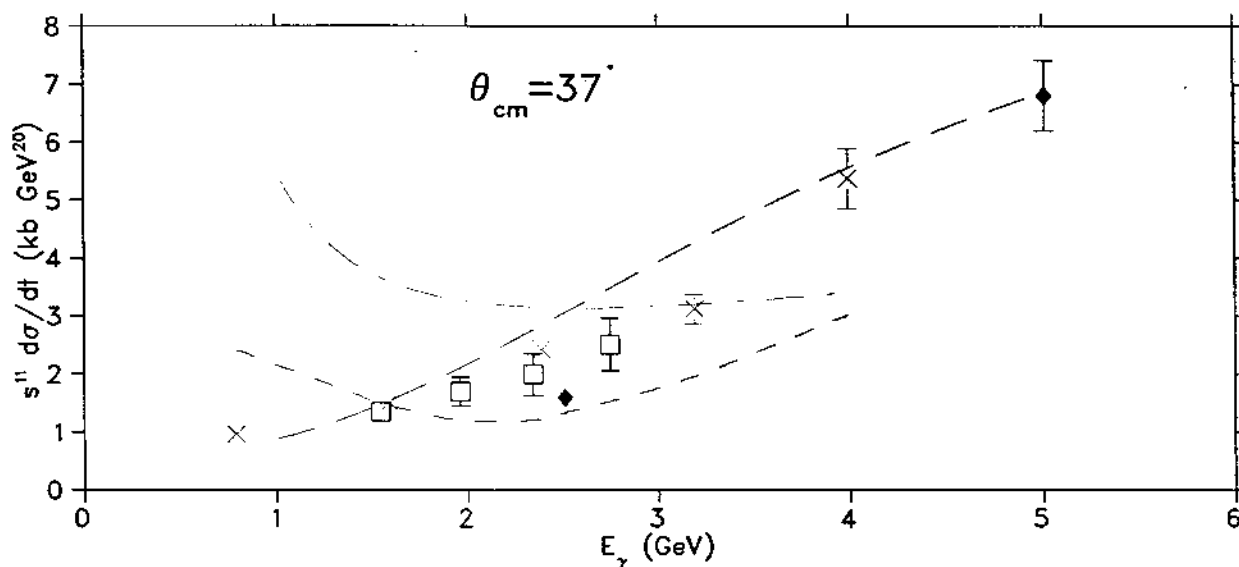
- Physics: Transition between Meson and Quark Picture and its characterization. Comparison of cross section with QCD and ME predictions.
- Setup: Reaction: $d(\gamma, p)n$ $\Theta_{cm}=36, 53, 70$ deg
 E_γ : 5.0 and 5.5 GeV I_B : 25-40 μA
6% Copper Radiator, LD₂ target, proton in the HMS



- Analysis: Preliminary results for 5.0 GeV available
Newer results for 5.0 GeV are about to come out.
Work on 5.5 GeV data started.

PQCD: $\frac{d\sigma}{dt} \sim \frac{1}{s^n}$ "Constituent counting rule"

JLab E96-003 $d(\gamma, p)n$ Very Preliminary



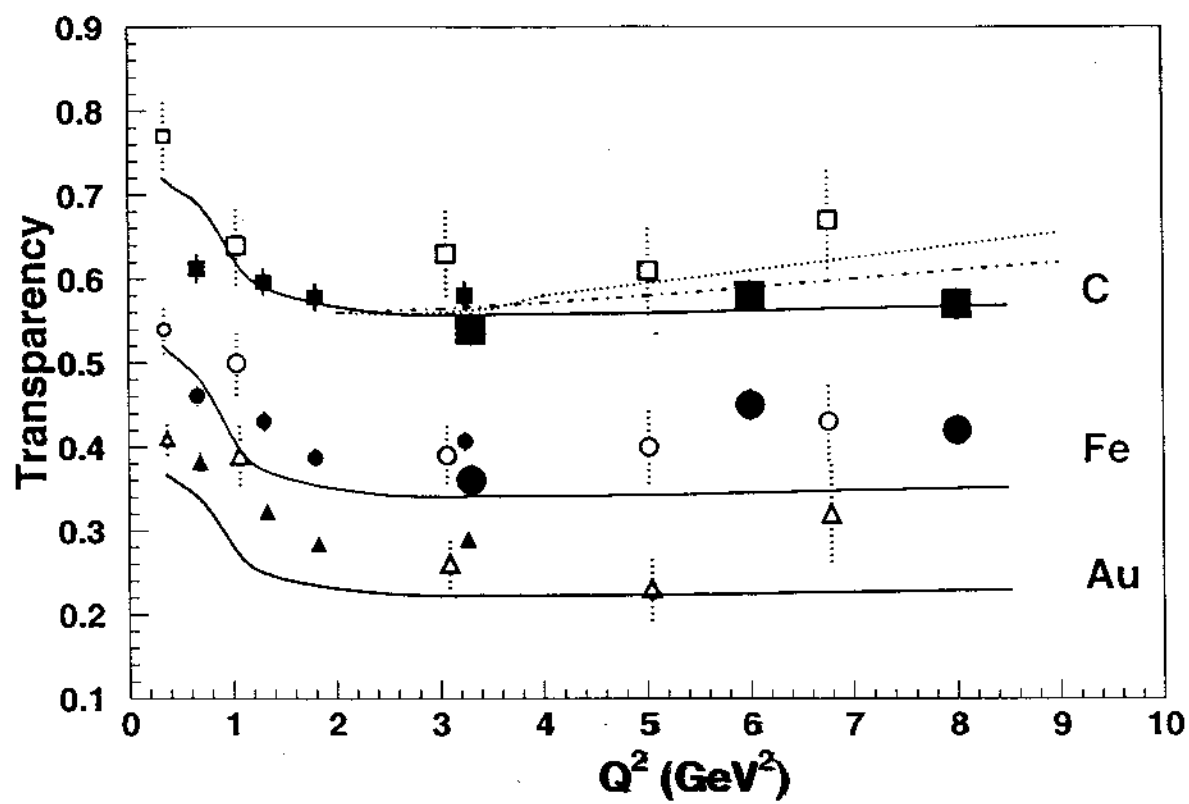
E91-007: Search for Color Transparency in Quasielastic (e,e'p) Scattering

- Physics: Color Transparency: From fundamental considerations it is predicted (Brodski, Mueller 1984) that fast protons scattered from the nucleus will have decreased final state interactions.

E91-007 has higher precision than SLAC NE-18 and extended Q^2 range

- Setup: Targets: LH_2 , LD_2 , C, Fe $e \rightarrow \text{HMS}$, $p \rightarrow \text{SOS}$
 $Q^2 = 3.3, 6.0, 8.0 \text{ (Gev/c)}^2$ $I_B : 30\text{-}50\mu\text{A}$

- Analysis: Online results available.
Currently looking at $\text{H}(e,e')$ and $\text{H}(e,e'p)$ for calibration and systematics



E94-110: Measurement of $R = \sigma_L/\sigma_T$ in the Nucleon Resonance Region

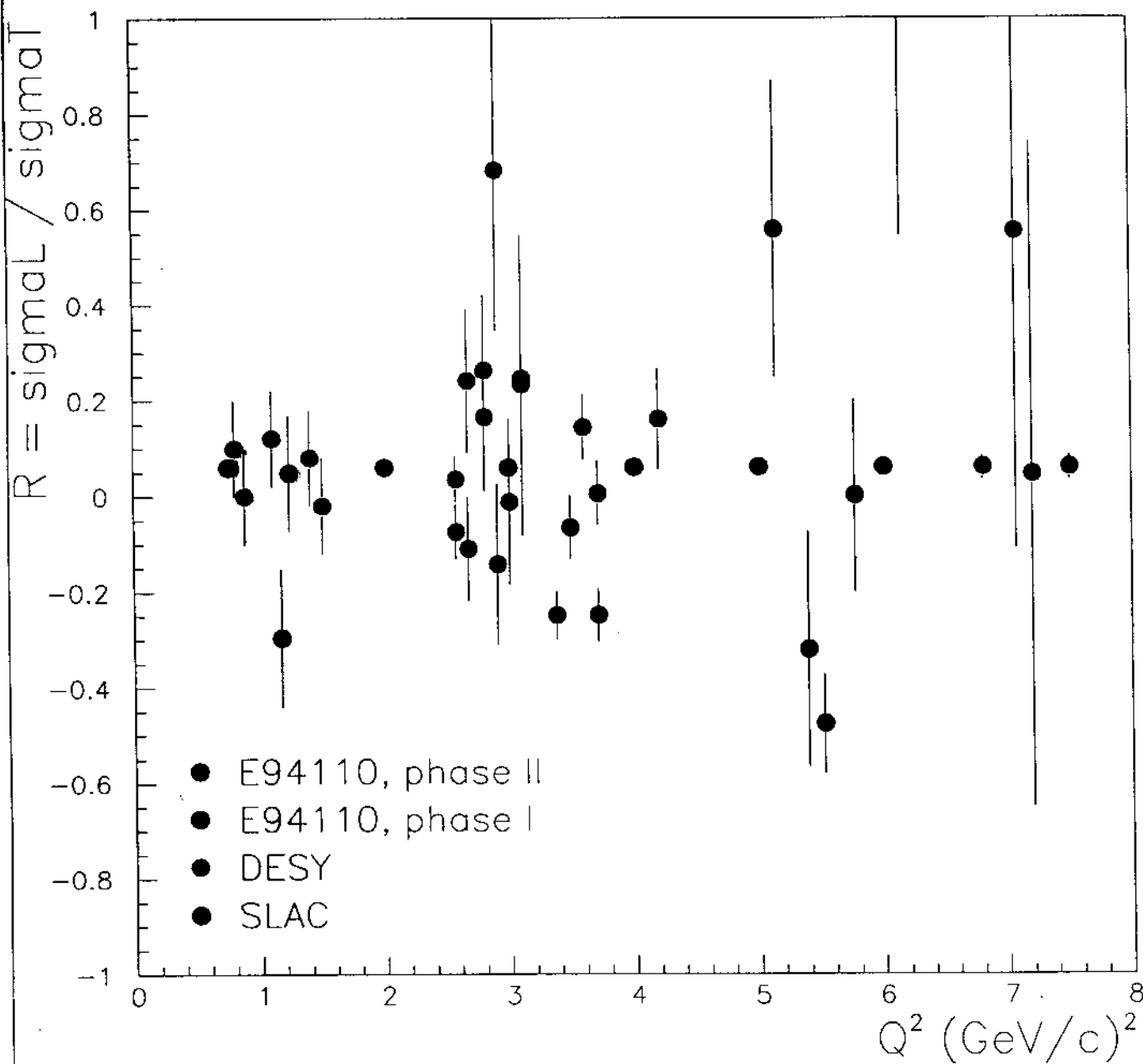
- Physics: R well measured in elastic and deep inelastic region but poorly known in Resonance Region ($\Delta R/R > 1$).

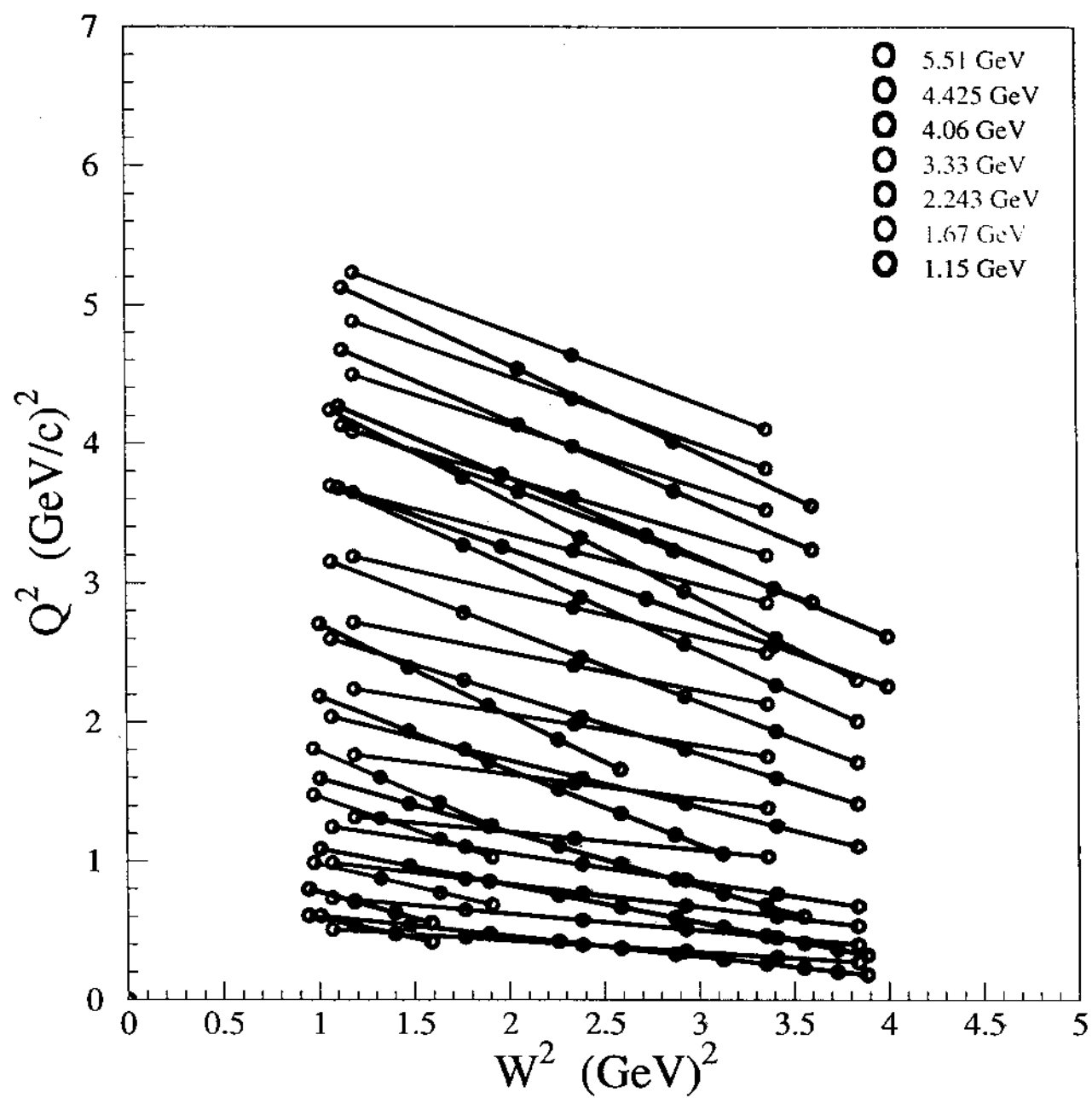
E94-110: $\Delta R/R \approx 0.1$

Test of *Bloom-Gilman Duality*

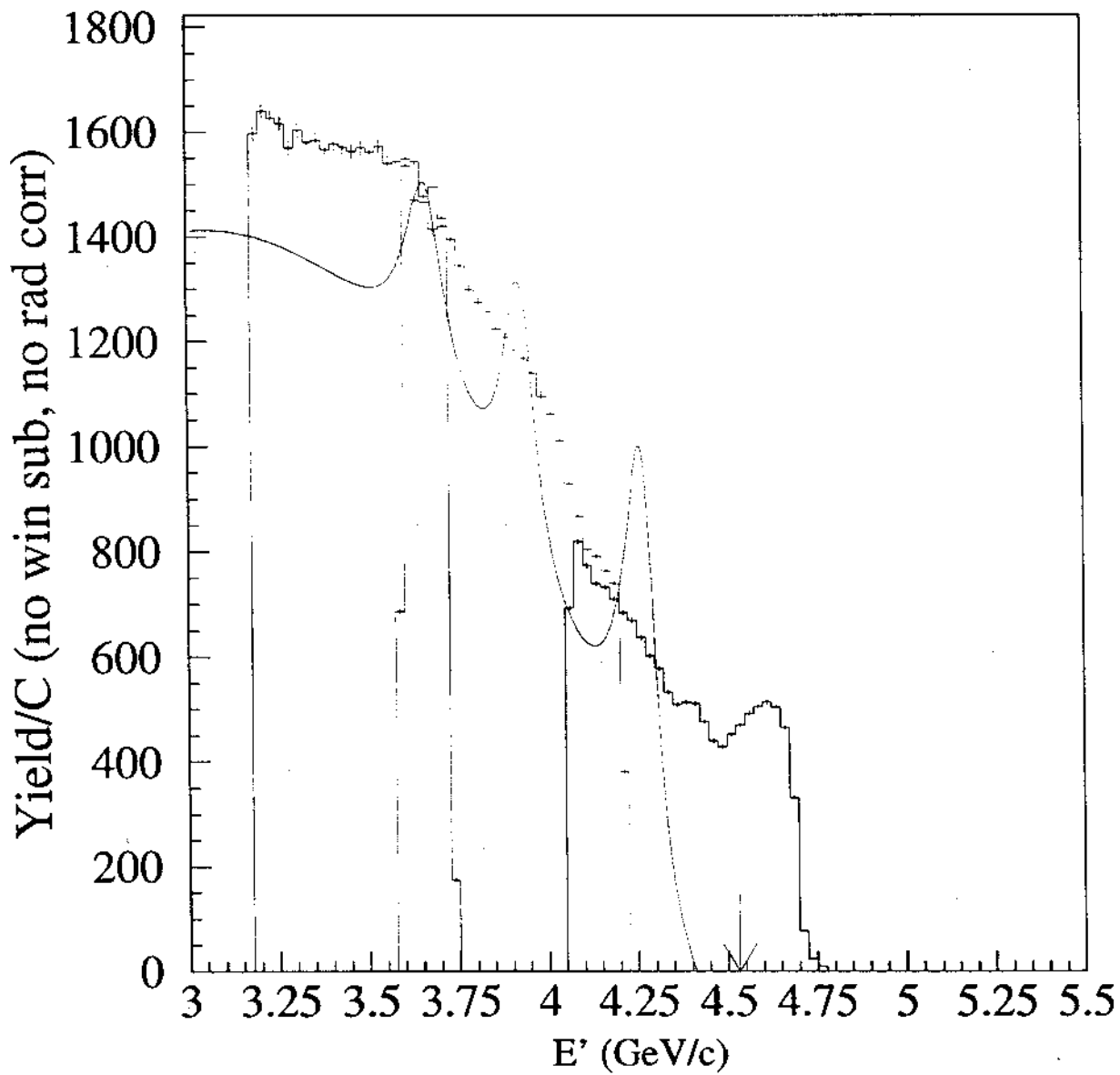
- Setup: LH_2 target, electron in the HMS
Energies: 1.15 .. 5.5 GeV $I_B = 60 \pm 2 \mu\text{A}$
 W^2 : 1.0 .. 4.0 GeV^2 Q^2 : 0.2 .. 5.2 $(\text{GeV}/c)^2$
175 out of planned 182 settings were taken
- Analysis: Detector calibrations in progress for later L/T separation (no quick results!)
Some background physics done

E94-110 (Projected) and Global Data Comparison





$\times 10^4$ $E_b = 5.498 \text{ GeV}/c$, $\theta_{\text{HMS}} = 15.51 \text{ deg.}$



E97-006: Correlated Spectral Function and (e,e'p) Reaction Mechanism

- Physics: Measurement of correlated part of the spectral function $S(k,E)$

Depopulation of valence orbits in nuclei due to short range correlations.

In scattering picture: Events at large E_m and large P_m .

Problem: Contamination by multistep processes.

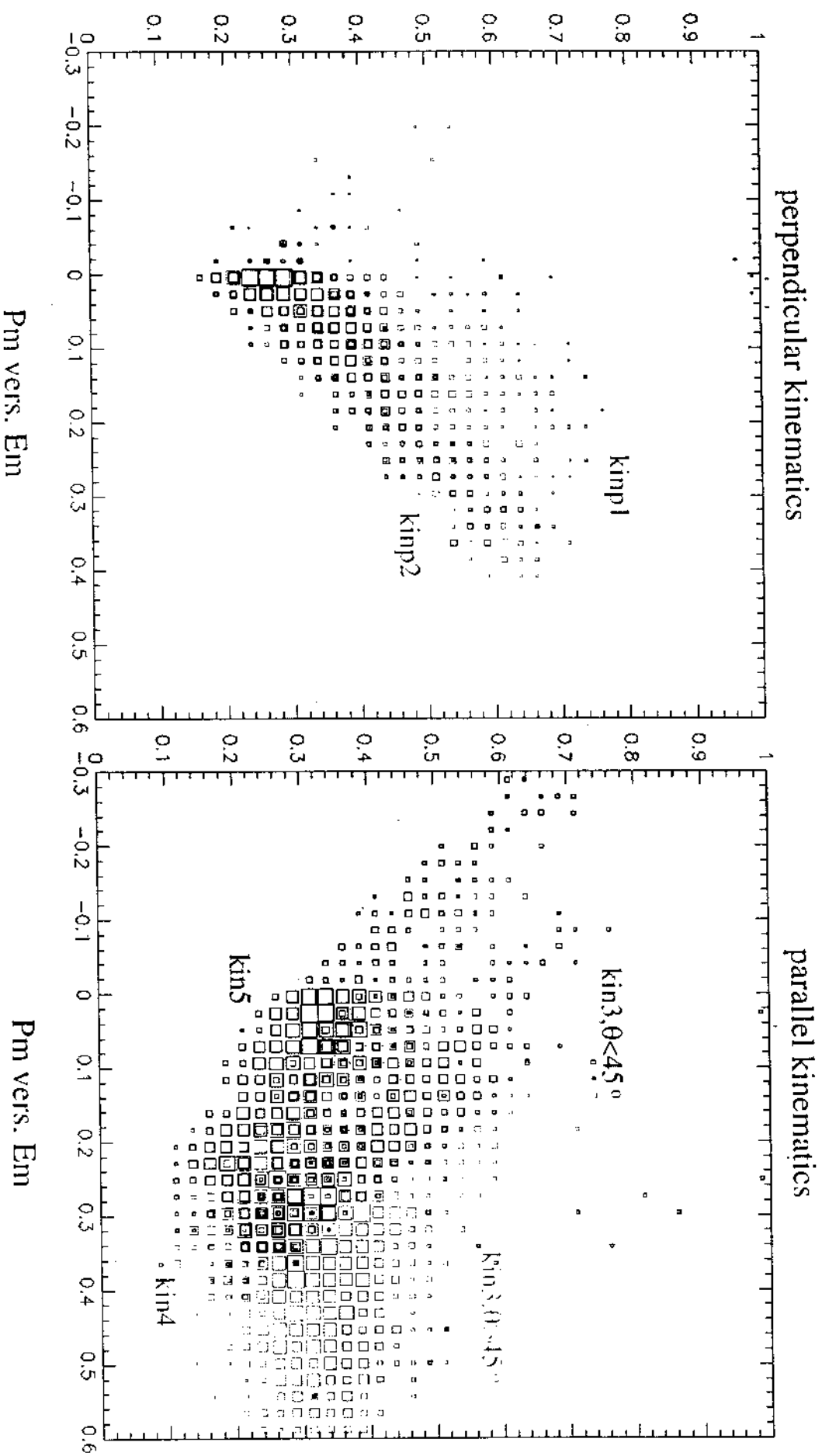
Solution:

1. Choose kinematics with least contamination
2. Theoretical program for calculation of multistep processes.
3. For consistency check: different A, kinematics with high contamination.

- Setup: Targets: C, Al, Fe, Au, LH₂
e → HMS, p → SOS
3 parallel and 2 perpendicular kinematics
Energy: 3.1 GeV I_B : 10-60 μ A

- Analysis: Calibration: Looking at beam stability (energy and position)
Normalization: Comparing Hydrogen data with Monte Carlo

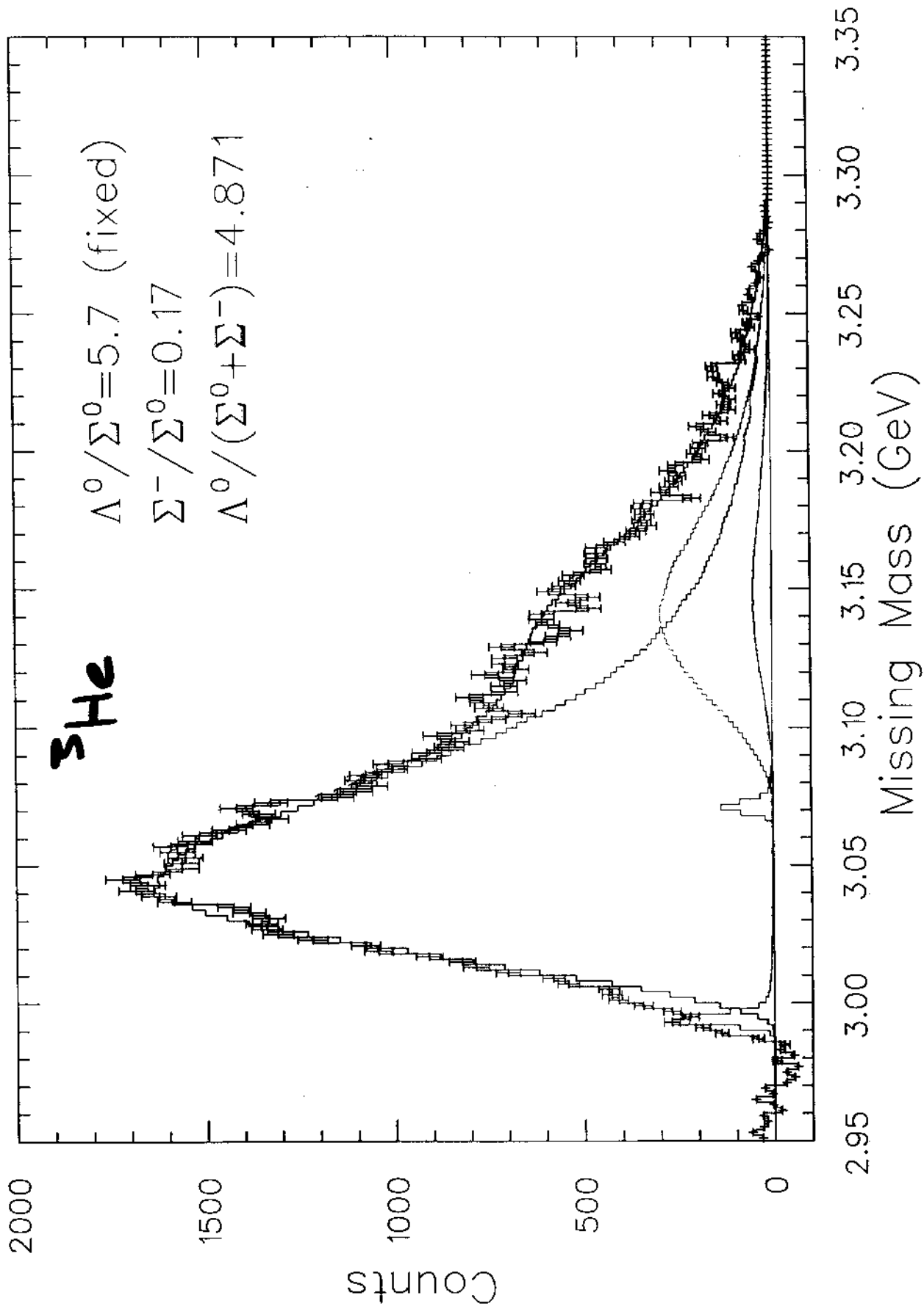
97-006: correlated spectral function ($e, e'p$) (I. Sick)

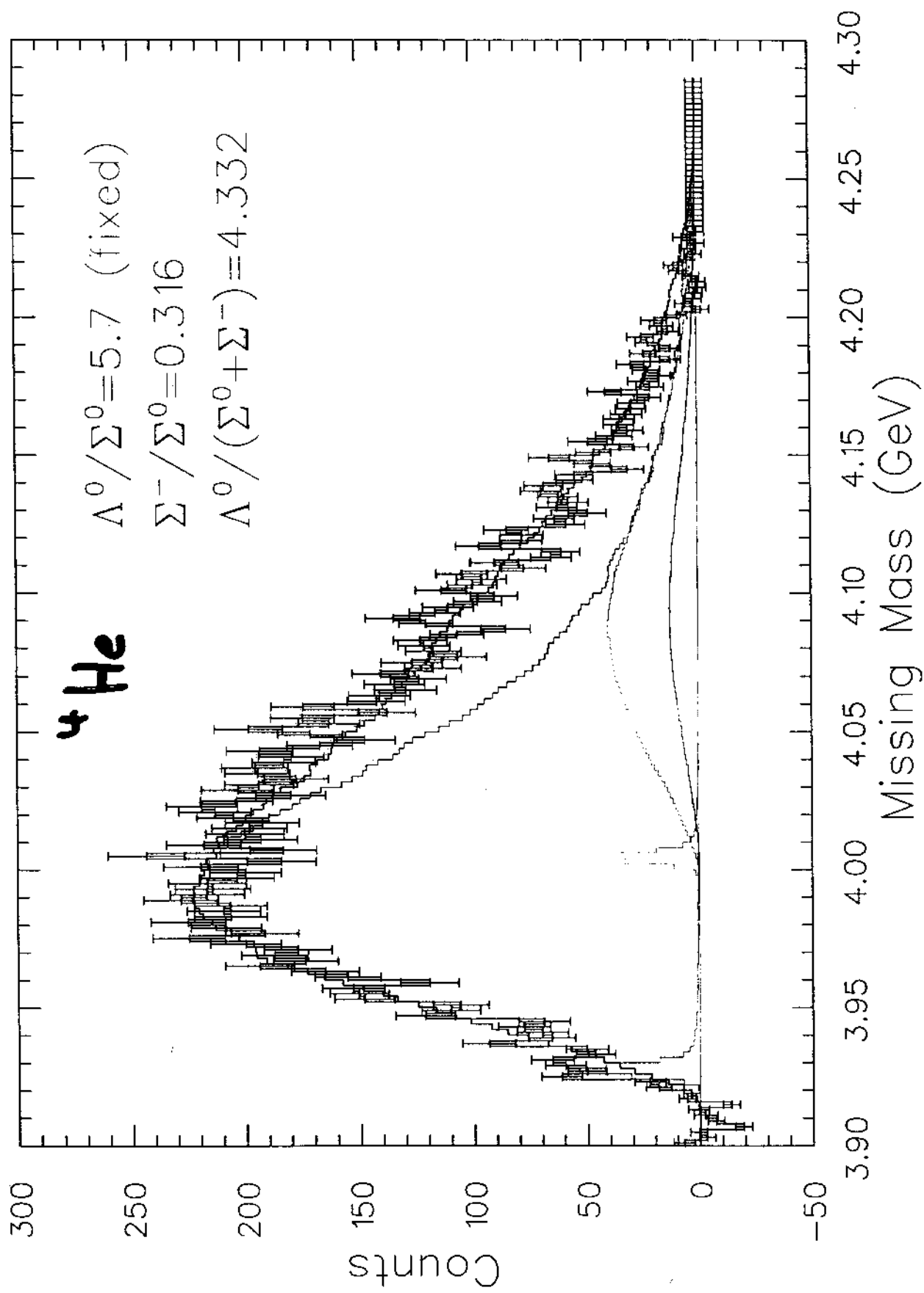


raw data: no corrections applied

E91-016: Electroproduction of Kaons and Light Hypernuclei

- Physics: Strange Baryons in Nuclei: Λ and Σ
D(e,e'K): study ΛN and ΣN interaction
He(e,e'K): Search for Hypernuclei
- Setup: (e,e'K⁺) on ^3He , ^4He , LD₂ and LH₂
e \rightarrow HMS, K \rightarrow SOS (with aerogel)
E = 3.25 GeV $Q^2 = 0.35 \text{ (GeV/c)}^2$
Kaon angles with respect to the virtual photon: 0, 6, 12 deg





Spin Dependence of the Effective ΛN Interaction

Systematic High Precision Hypernuclear Spectroscopy Using $(e,e'K^+)$ Reaction

TJNAF Hall C Experiment - Exp89-009

Collaboration

Hampton University - **L. Tang** (co-spokesperson)

K. Assamagan, S. Averay, O.K. Baker, L. Core, W.W. Buck, L. Gan, A. Gasparian, P. Gueye, W. Hinton, C. Keppel, L. Yuan

University of Houston - **Ed. Hungerford** (co-spokesperson)

M. Ahmed, A. Empl, K. Lan, B. Mayes, L. Pinsky, M. Sasour, M.Y. Yong

Brookhaven National Laboratory - **R. Chrien** (co-spokesperson)

M. May, E. Meier, A. Rusek, D. Sutter

TJNAF - C. Armstrong, R. Carlini, T. Eden, R. Ent, D. Mack, J. Mitchell, W. Vulcan, S. Wood, C. Yan

Tohoku University, Japan - Y. Fujii, O. Hashimoto, K. Maeda,

T. Miyoshi, K. Ozawa, Y. Sato, T. Takahashi, H. Tamura

North Carolina A&T State University - A. Ahmidouch, S. Danagouliau, R. Sawafte

Louisiana Tech University - B. Anderson, M. Elaasar, D. Greenwood, K. Johnston, J. Price, N. Simicevic, S. Wells

Temple University - C. Martoff

Florida International University - W. Boeglin, L. Kramer, P. Markowitz, B. Raue, J. Reihold

Yerevan Physics Institute, Armenia - T. Amatouni, A. Margarian, H. Mkrtchyan, V. Tadevosyan

University of Bucharest, Romania - T. Angelescu, A. Mihul

University of Zagreb, Croatia - D. Androic, I. Bertovic, D. Bosnar, M. Furic, T. Petkovic, M. Planinic

STATUS OF E89-009 (HNSS) *Phase I*

- SCHEDULE (TENTATIVE):

Installation - ~~12/8/99 to 3/2/00~~ 12/16/99 - 2/24/00

Run - ~~3/3 to 5/22/00~~ 2/25/00 - 5/14/00

- READINESS REVIEW:

7/29/1999

- GOALS TO BE ACCOMPLISHED:

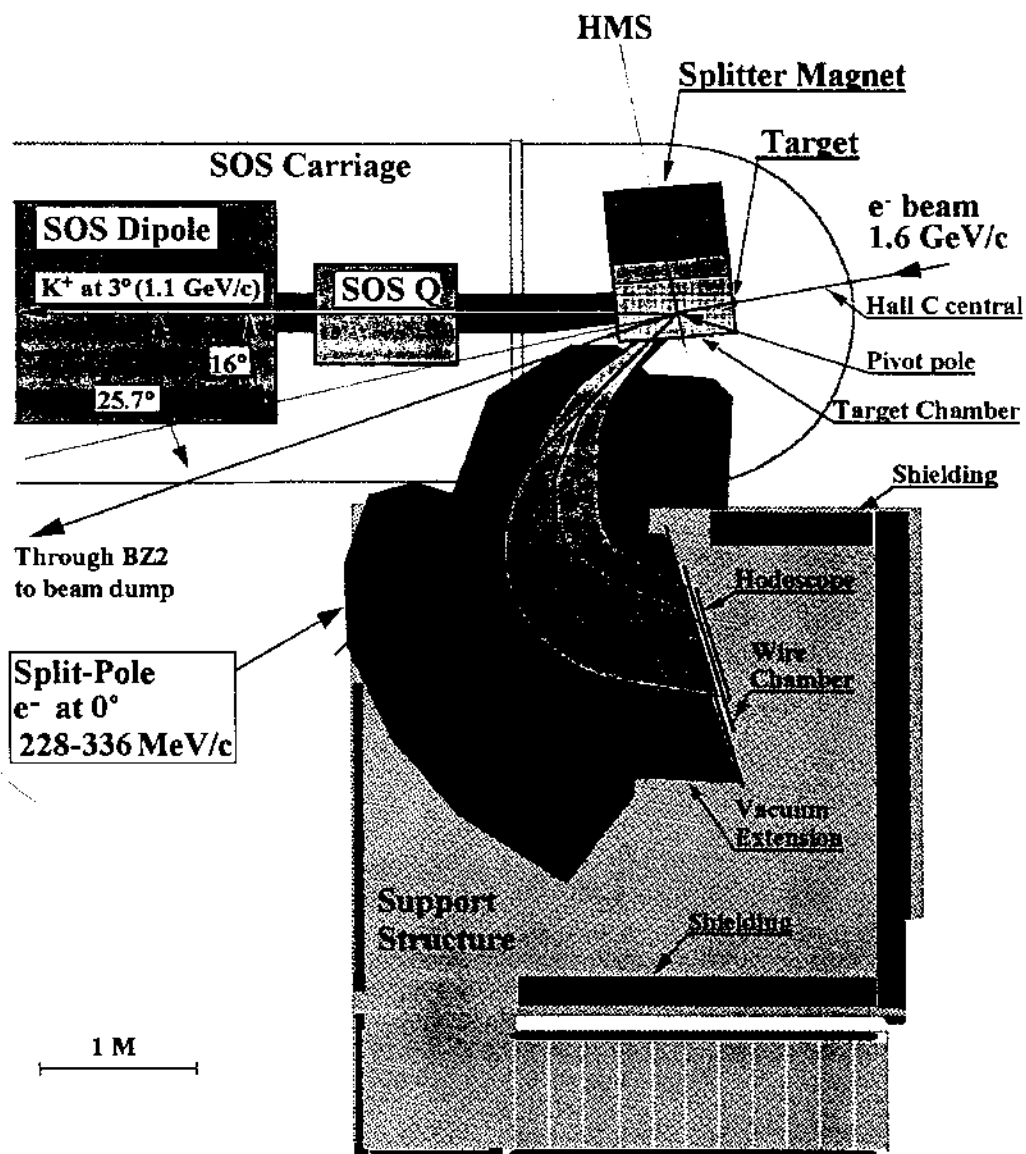
1. Produce and study the new spectroscopy which are never seen before
2. Examine the best resolution of current HNSS;
3. Demonstrate the technique of tagging on zero degree scattered electrons; and
4. Study the feasibility of using HNSS system for future hypernuclear experiments at Jlab.

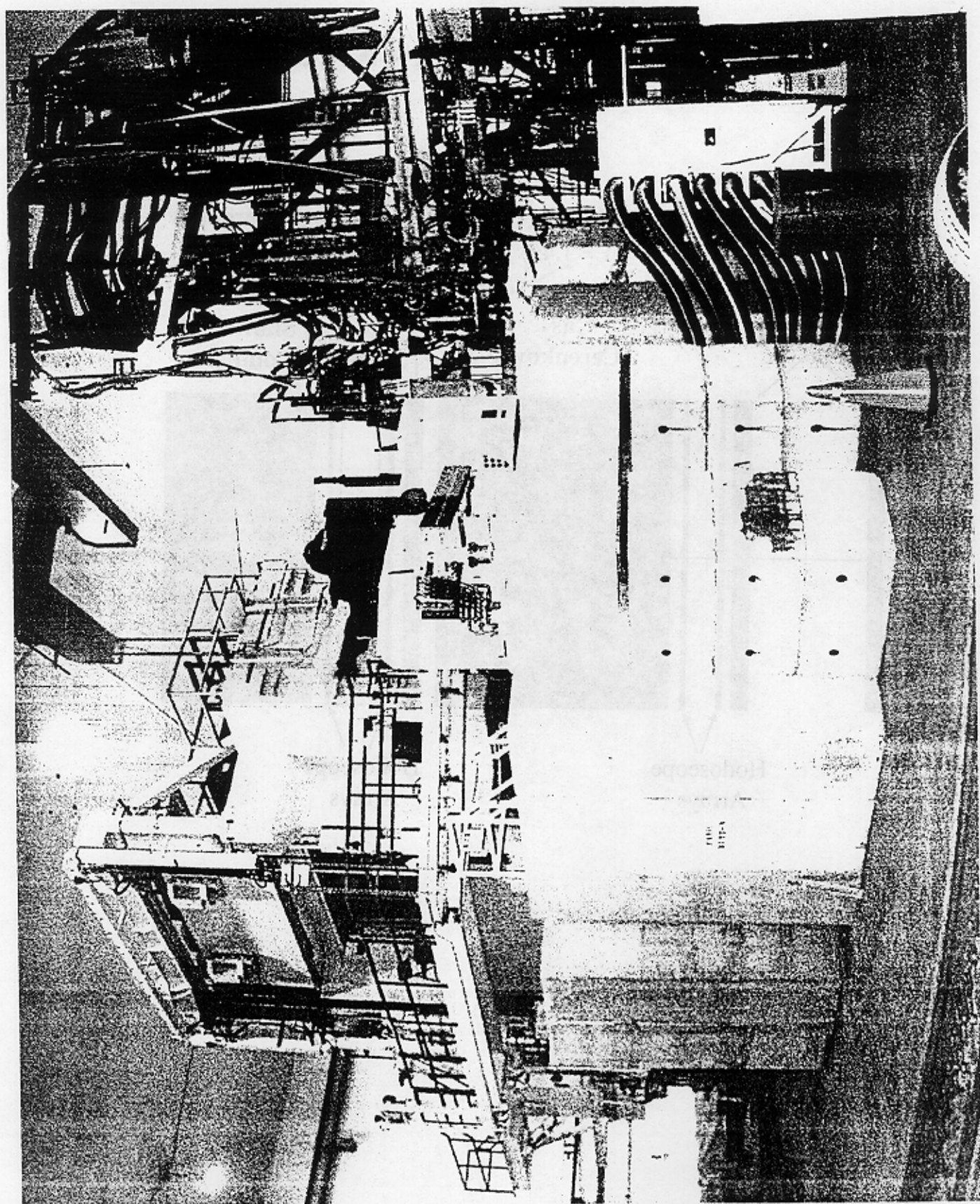
- HYPERNUCLEAR SYSTEM TO BE STUDIED:

MINIMUM: ${}^7_{\Lambda}\text{He}$, ${}^9_{\Lambda}\text{Li}$, ${}^{12}_{\Lambda}\text{B}$ (plus R&D on ${}^{28}_{\Lambda}\text{Al}$)

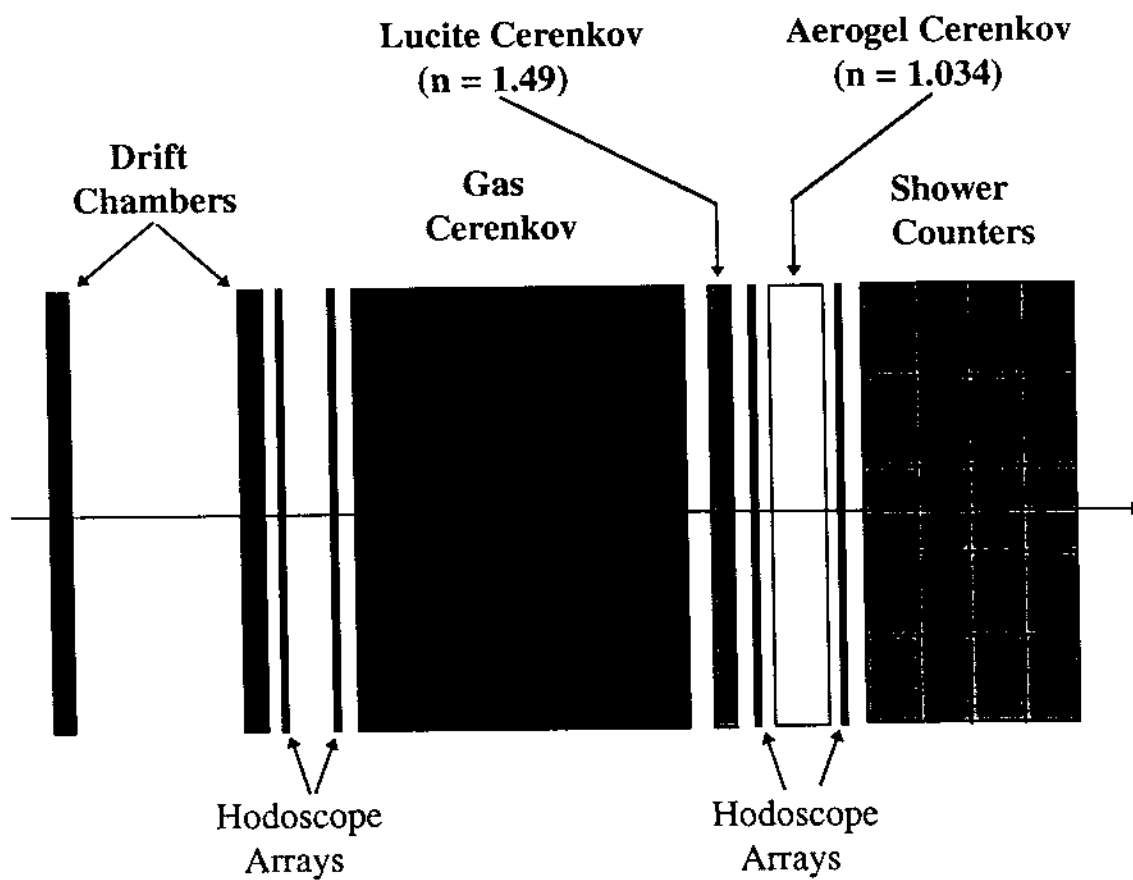
MAXIMUM: ${}^6_{\Lambda}\text{He}$, ${}^7_{\Lambda}\text{He}$, ${}^9_{\Lambda}\text{Li}$, ${}^{10}_{\Lambda}\text{Be}$, ${}^{11}_{\Lambda}\text{Be}$, ${}^{12}_{\Lambda}\text{B}$, ${}^{16}_{\Lambda}\text{N}$
(plus R&D on ${}^{28}_{\Lambda}\text{Al}$)

TOP VIEW OF EXP89-009 APPARATUS



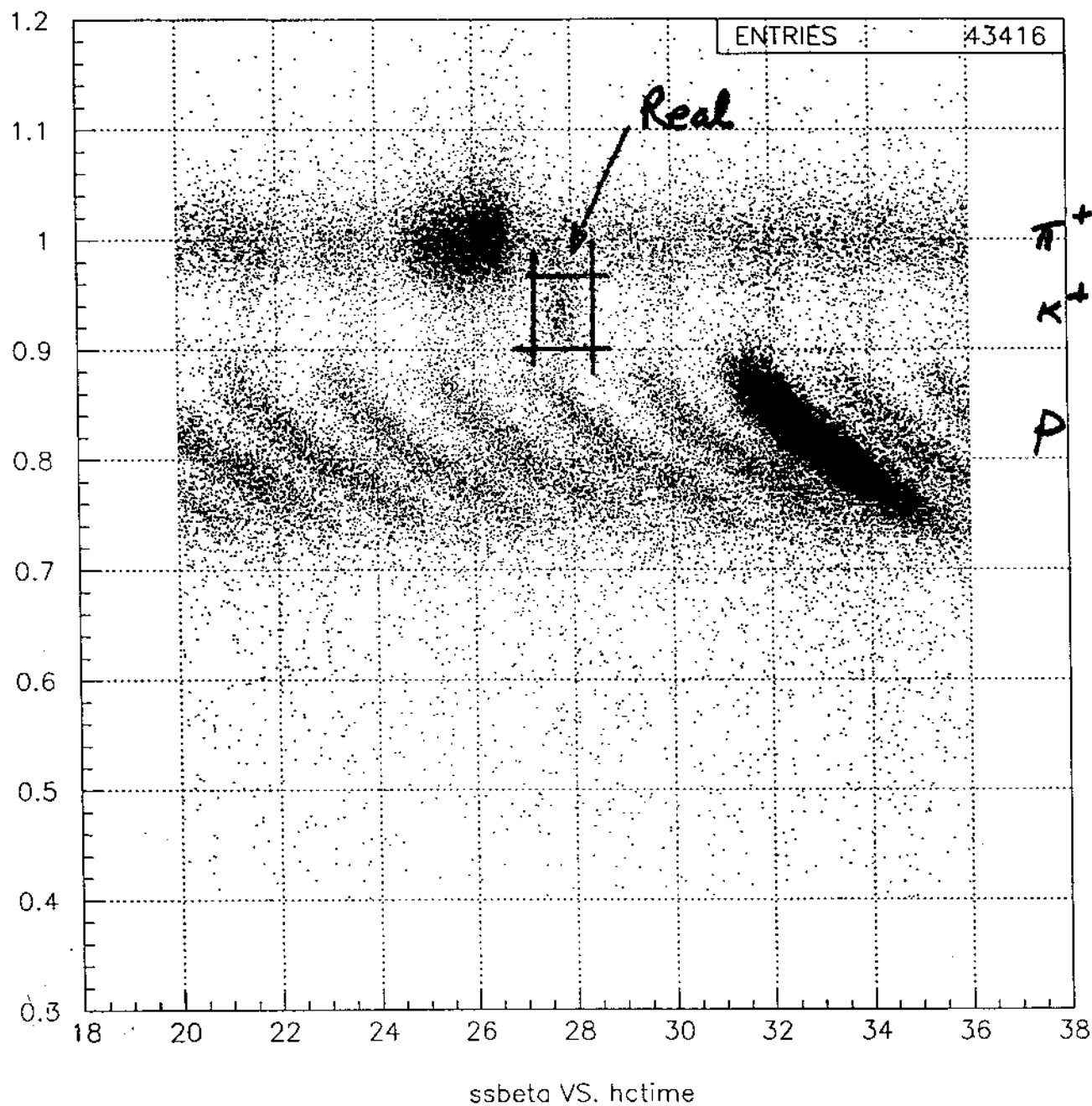


SOS DETECTOR PACKAGE



Obtained from E91-016

1999/11/29 09.51



Missing Mass Resolution

For 1.645 GeV beam

1. Contributions

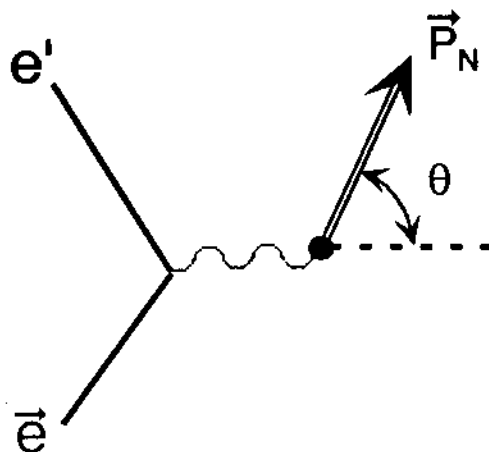
- Splitter+Split-Pole 120 keV
- Beam 160 keV
- Splitter+SOS 550~800 keV
- Target 20 keV
- Scattering angles 200 keV

● Total 600~1000 keV

Actual beam energy: 1.864 & 1.723 GeV

G_E^n - Charge Form Factor of the Neutron

- Fundamental parameter for nuclear structure
- Test nucleon models
- Current world results are inconsistent



$\vec{N}(\vec{e}, e' N)$

Pol. Target
(Day/Mitchell)

or

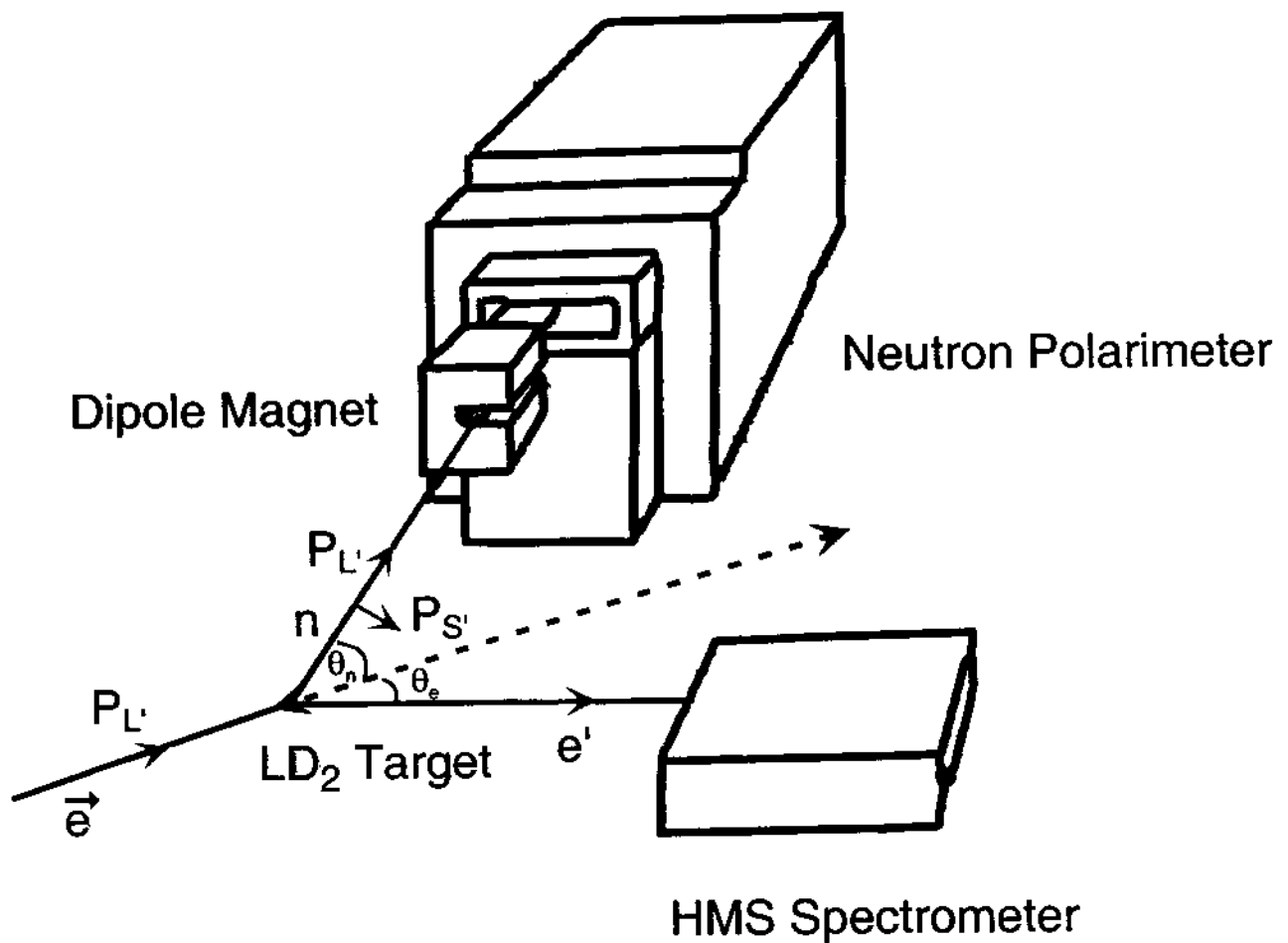
$N(\vec{e}, e' \vec{N})$

Recoil Polarization
(Madey/Kowalski)

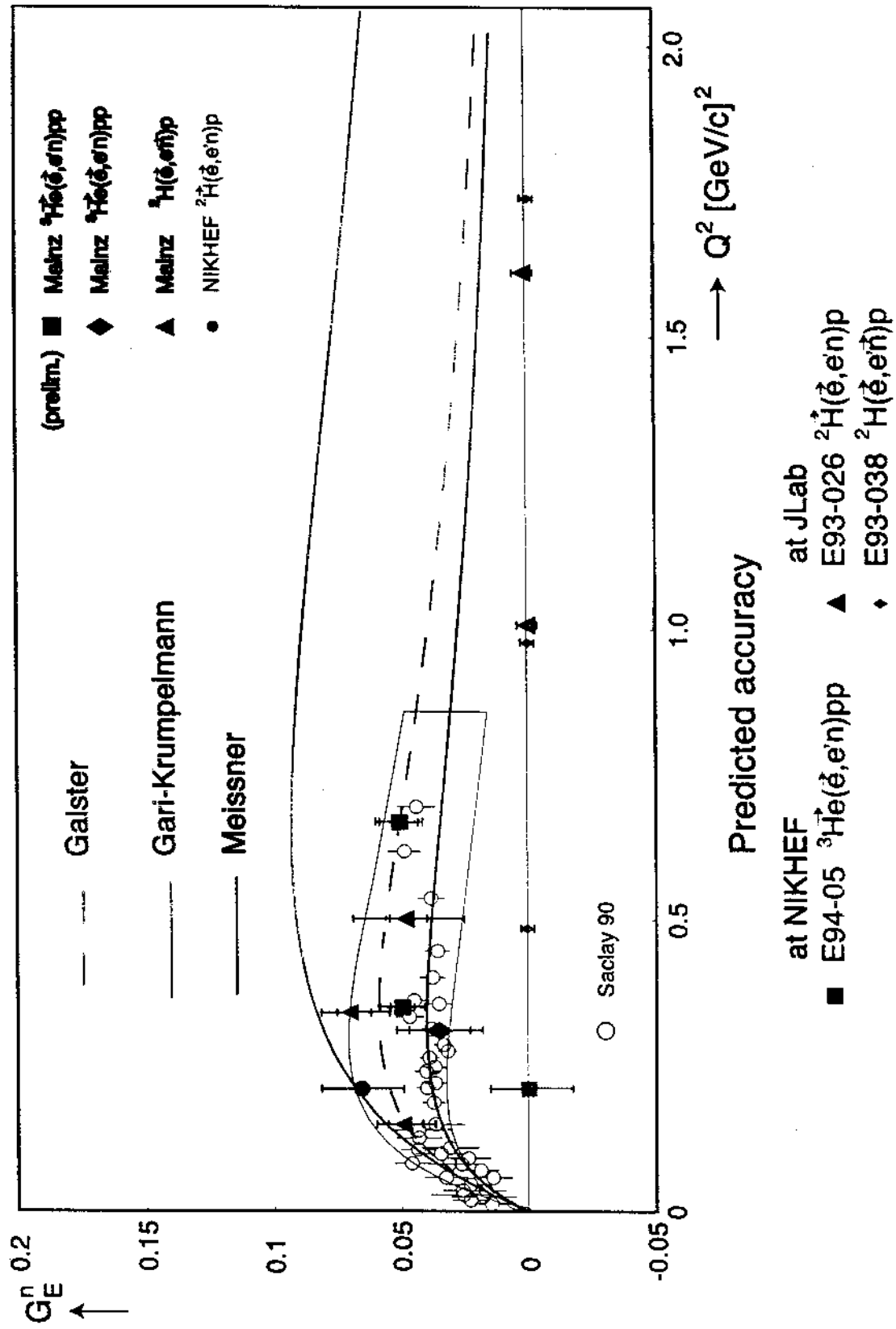
- Complementary techniques with different systematics

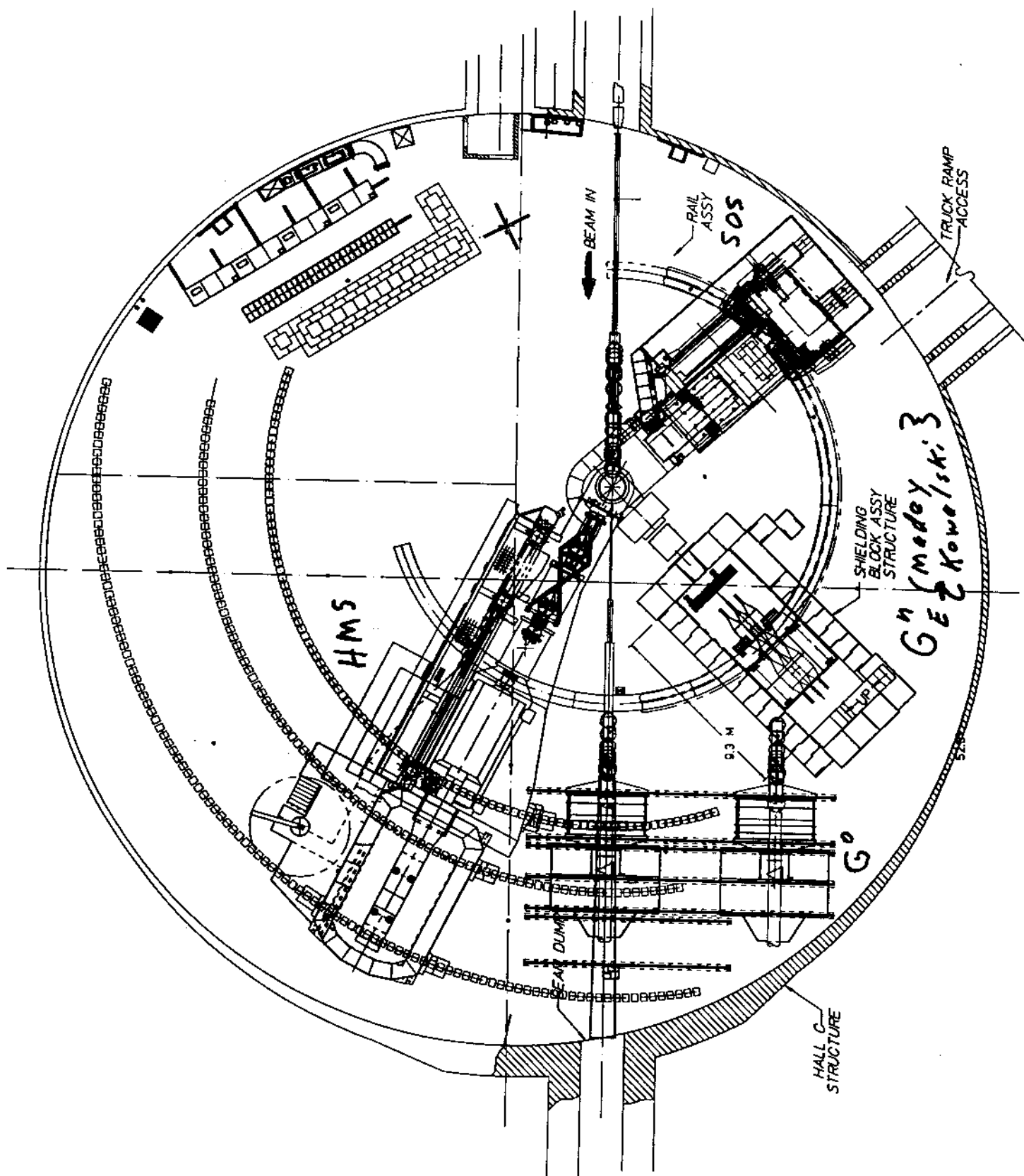
Schematic of G_E^n Apparatus

${}^2_1\text{H}(\vec{e}, e'\vec{n})p$ quasielastic

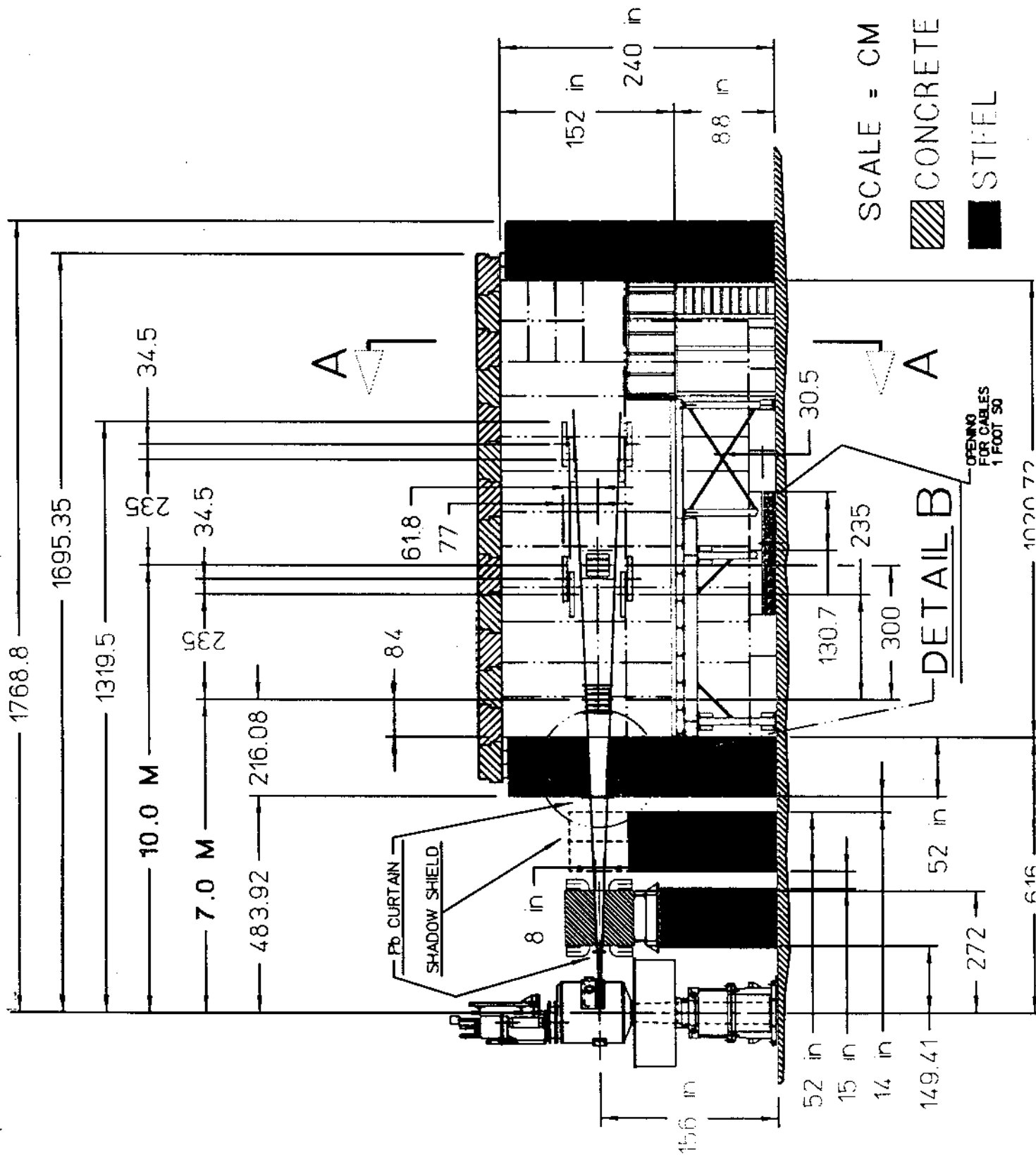


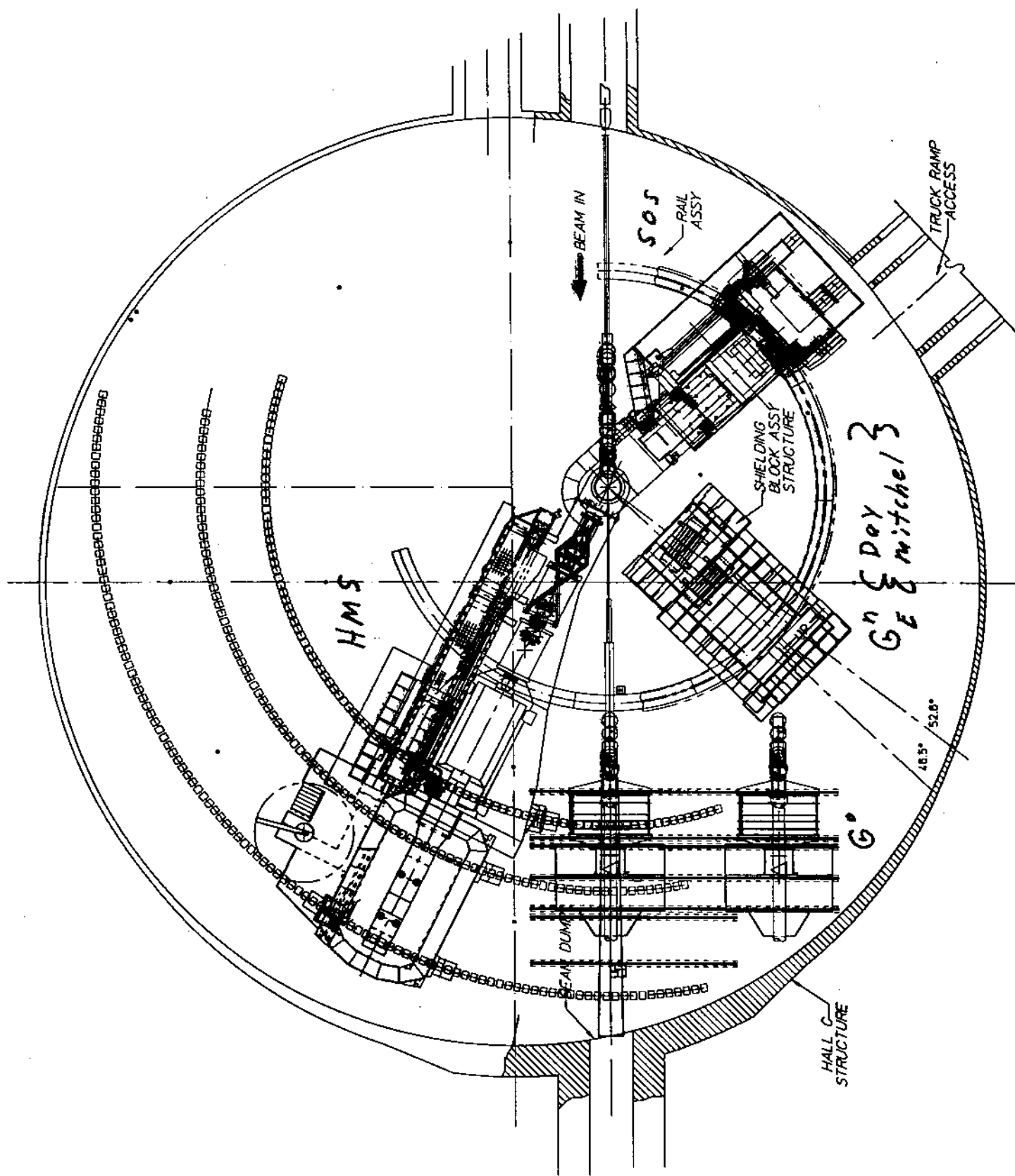
$$g \equiv \frac{G_E^n}{G_M^n} = -K_R(\theta_e, Q^2) \frac{\xi_{S'}}{\xi_{L'}}$$





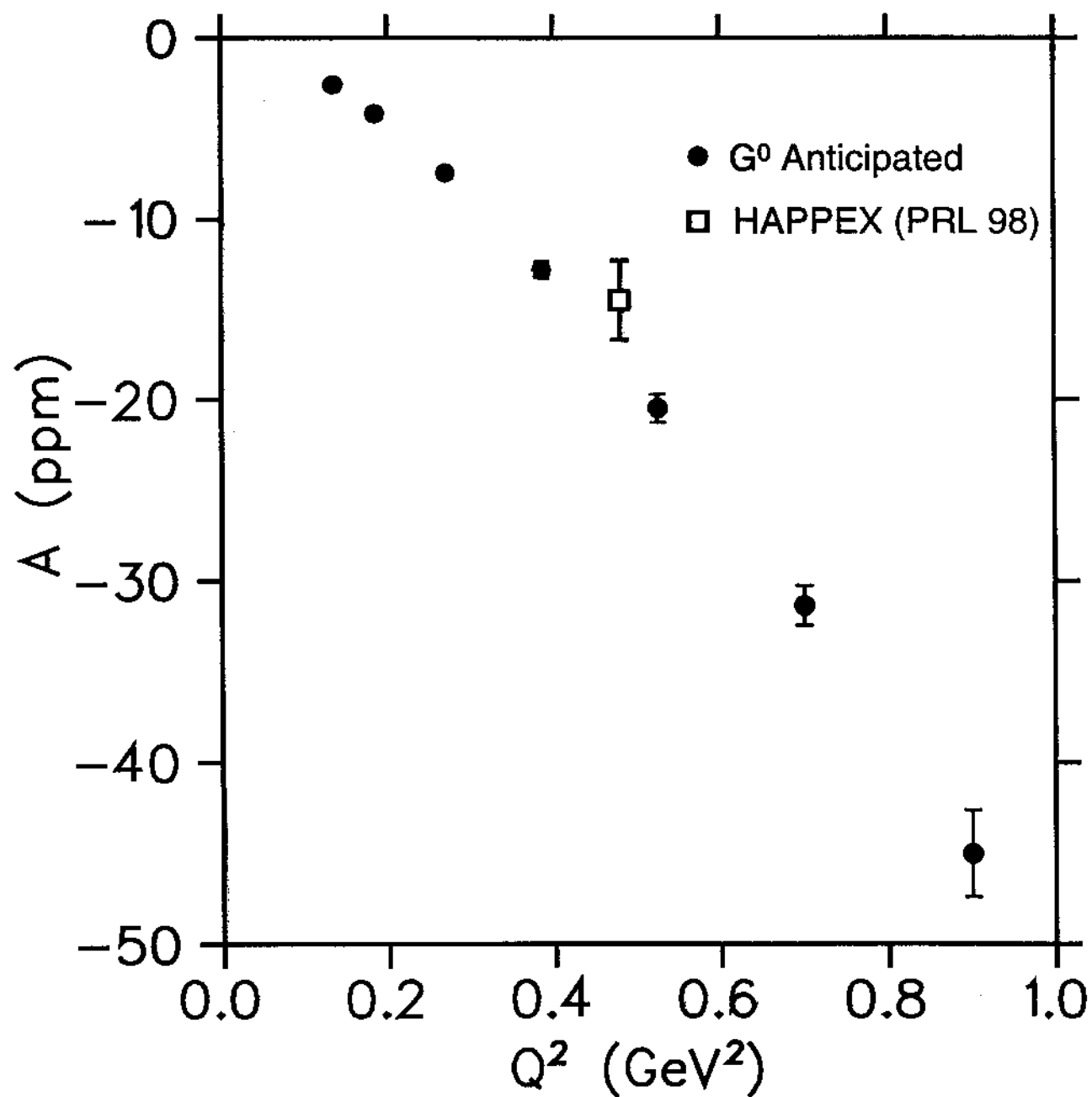
HALL C - AN VIEW



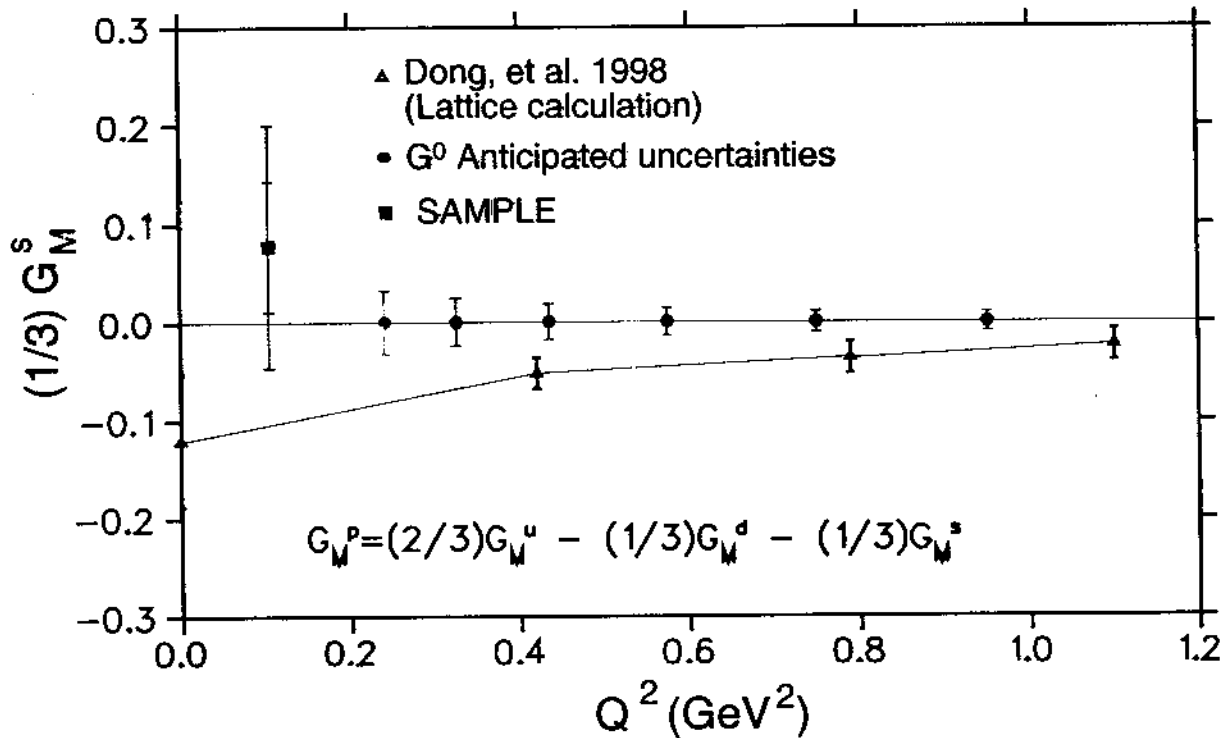
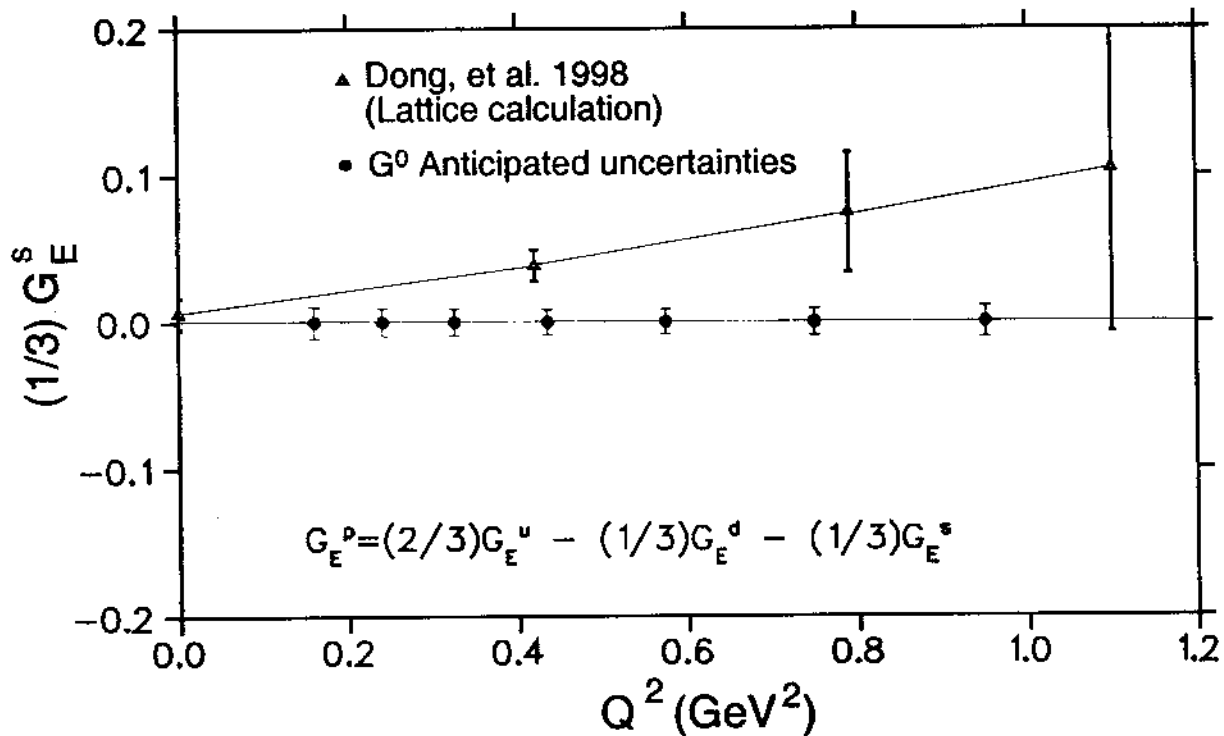


HALL C f LAN VIEW

G^0 Forward Asymmetries

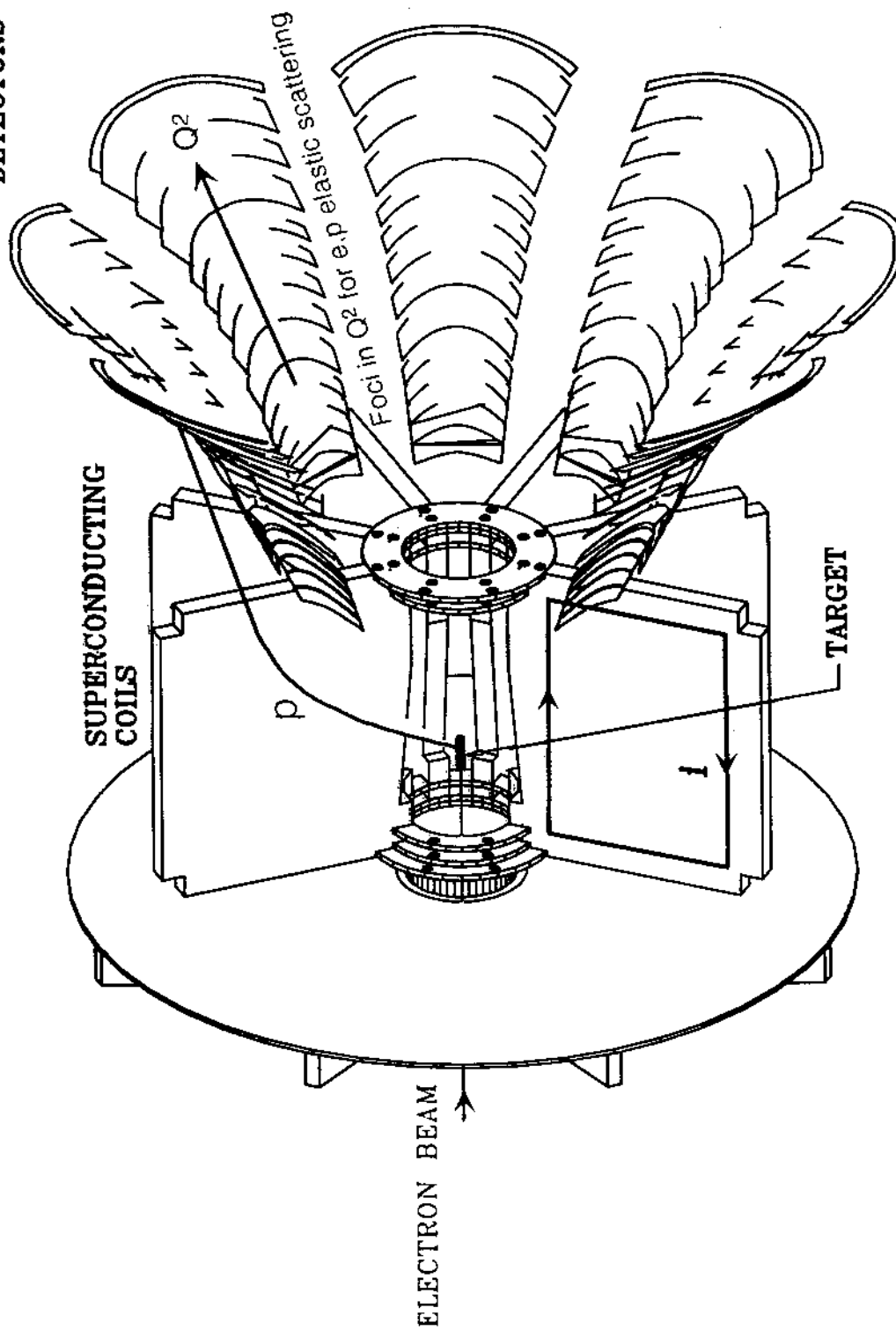


G^0 - Anticipated Uncertainties in Separated Form Factors



GO EXPERIMENT

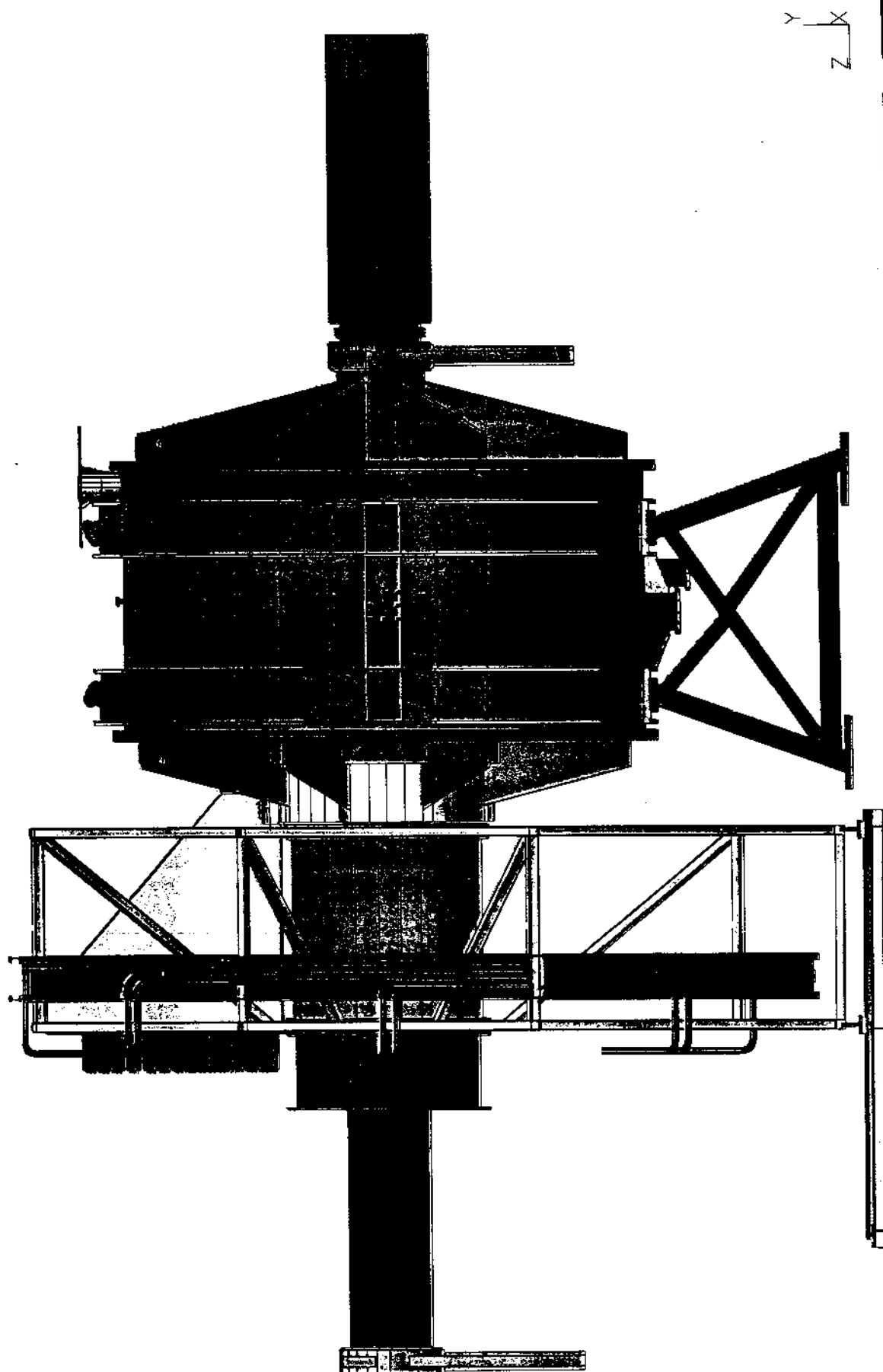
DETECTORS



28-Jan-99 08:11:26
Units : MM
Display : No stored Option

I-DEAS Master Series 6: Simulation

Database: d:\ideas\g0\layout-g0.mf1
View : SIDE1
Task : Master Assembly
Model: <none on workbench>



Instrumentation Upgrades

- All PMT/wire chamber H.V. supplies are now in counting house.
- Cryo-target upgrade:
 - *Short term:* Use correct bearings + minor overhaul.
 - *Long term:* New cryotarget system designed for ease of maintenance.
- HMS control electronics move.
- Beam dump tunnel work to reduce Hall backgrounds:
 - Remove misc. obsolete hardware.
 - Move diffuser farther down tunnel.
 - Install shielding labyrinth in tunnel.
 - New downstream beam pipe (removable for G^0)

Hall C Meeting

Wednesday, January 12, 2000

Plenary Session 08:30 am - 12:00 pm, ARC Center Auditorium

08:30 am - 8:50 am	General Status and Hall C Schedule 2000/2001	Carlini
08:50 am - 09:15 am	Summary of 1999 Physics Running	Zeier
09:15 am - 09:40 am	E89-009 (HNSS) Status	Tang
09:40 am - 10:00 am	E99-118 (NucR) Status	Bruell

10:00 am - 10:20 am Coffee Break

10:20 am - 10:40 am	E93-038 ($G_{\pi n}$) Status	Madey
10:40 am - 11:00 am	E93-026 ($G_{\pi n}$) Status	Day
11:00 am - 11:20 am	E96-002 (Resonance Spin) Status	Rondon
11:20 am - 11:40 pm	E99-016 (G^0) Status	Beck
11:40 am - 12:10 pm	Standard Model Tests	Jens Erler
12:10 pm - 12:30 pm	Jlab Experimental Opportunities	M. Finn

12:30 pm - 01:30 pm Lunch Break

Afternoon Session 01:30 pm - 07:00 pm, ARC Center Auditorium

Physics with a first phase SHMS (aka SHMS-Lite)
(essentially the SHMS but with a surplus resistive dipole capable of ~
6GeV/c & upgradable via a new superconducting dipole to 12GeV/c)

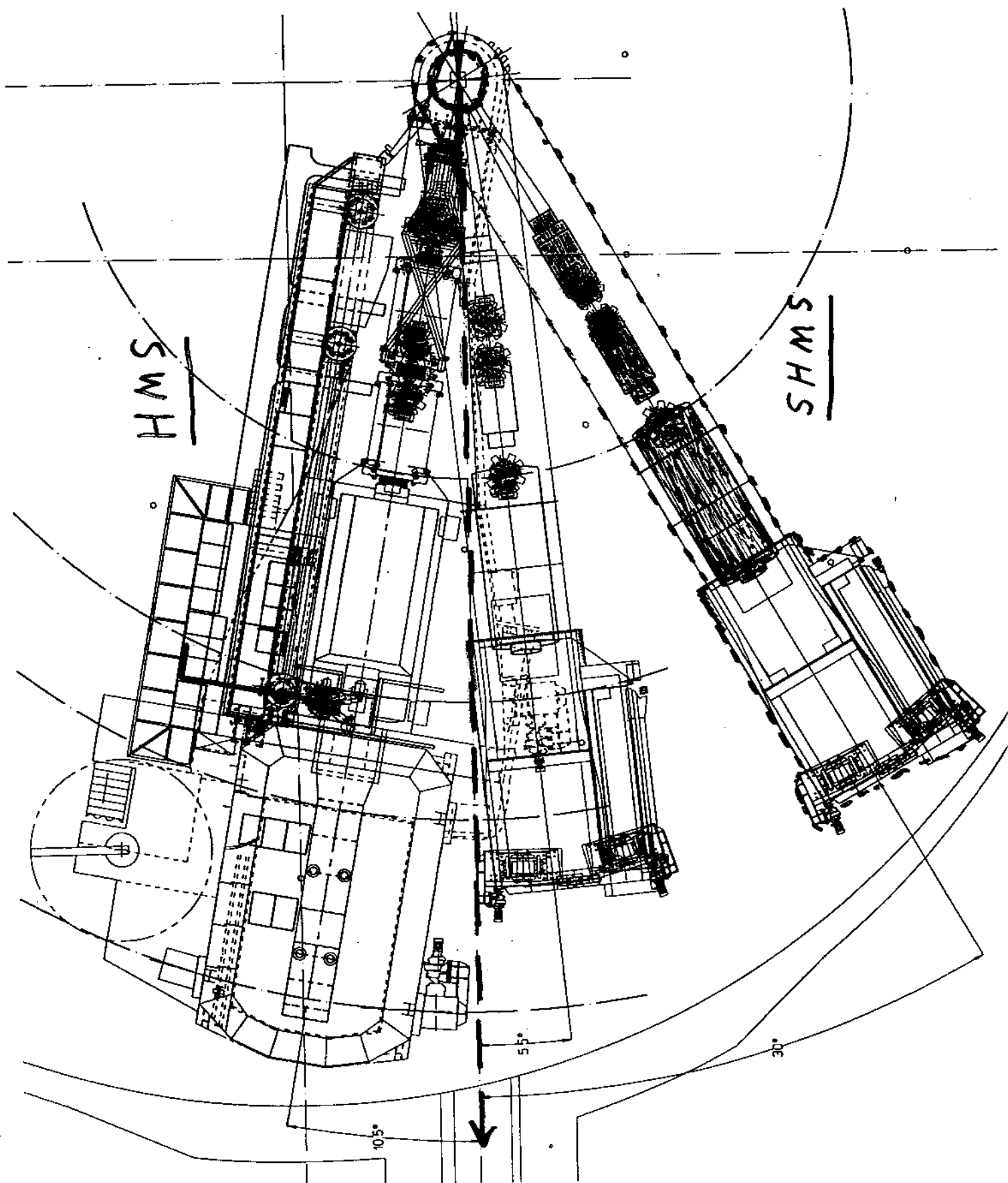
Organizers: Howard Fenker and Dave Potterveld

01:30 pm - 01:40 pm	Introduction	Carlini
01:40 pm - 02:00 pm	Pion Formfactor	Mack
02:00 pm - 02:20 pm	Meson Electroproduction & Duality	Armstrong
02:20 pm - 02:40 pm	Resonance Electroproduction	Stoler
02:40 pm - 03:00 pm	R in Kaon Electroproduction	Niculescu
03:00 pm - 03:20 pm	A Critical View of Spectrometer Requirements	Potterveld
03:20 pm - 03:40 pm	SHMS/SHMS-Lite Ion-Optics	Yan

03:40 pm - 04:00 pm Coffee Break

04:00 pm - 04:20 pm	Mechanical / Magnet Design	Brindza
04:20 pm - 04:40 pm	SHMS-Lite Detector Package	Fenker
04:40 pm - 05:00 pm	Particle Identification: TRD	Dunne
05:00 pm - 05:20 pm	Shower Counter	Tadevosyan
05:20 pm - 06:00 pm	Discussion: Mini-Workshop? SHMS-Lite Collaboration?	

07:00 pm Hall C Dinner



SHMS Base Design

Characteristic	SHMS	SHMS "lite"*
Configuration	QQD	QQD
P_{max} (GeV/c)	12	6
Solid Angle (msr)	1.7-3.0	1.7-3.0
In-plane (mr)	13	13
Out-of-plane (mr)	42	42
Minimum Scattering Angle (deg)	5.5	5.5
Bend Angle (deg)	18.9	18.3
D (cm/%)	1.852	1.765
D/M (cm/%)	3.12	3.12
Acceptance (%)	± 10	± 10
Focal Plane Angle (deg)	4.69	5.07
Resolution:		
Momentum	10^{-3}	10^{-3}
In-plane angle (mr)	0.9	0.9
Out-of-plane angle (mr)	3.0	3.0
Dipole Power (MW)	.03	0.7

* Uses SLAC B203 dipole *(or equiv.)*

Phased Approach for Super-HMS

Forming three working groups

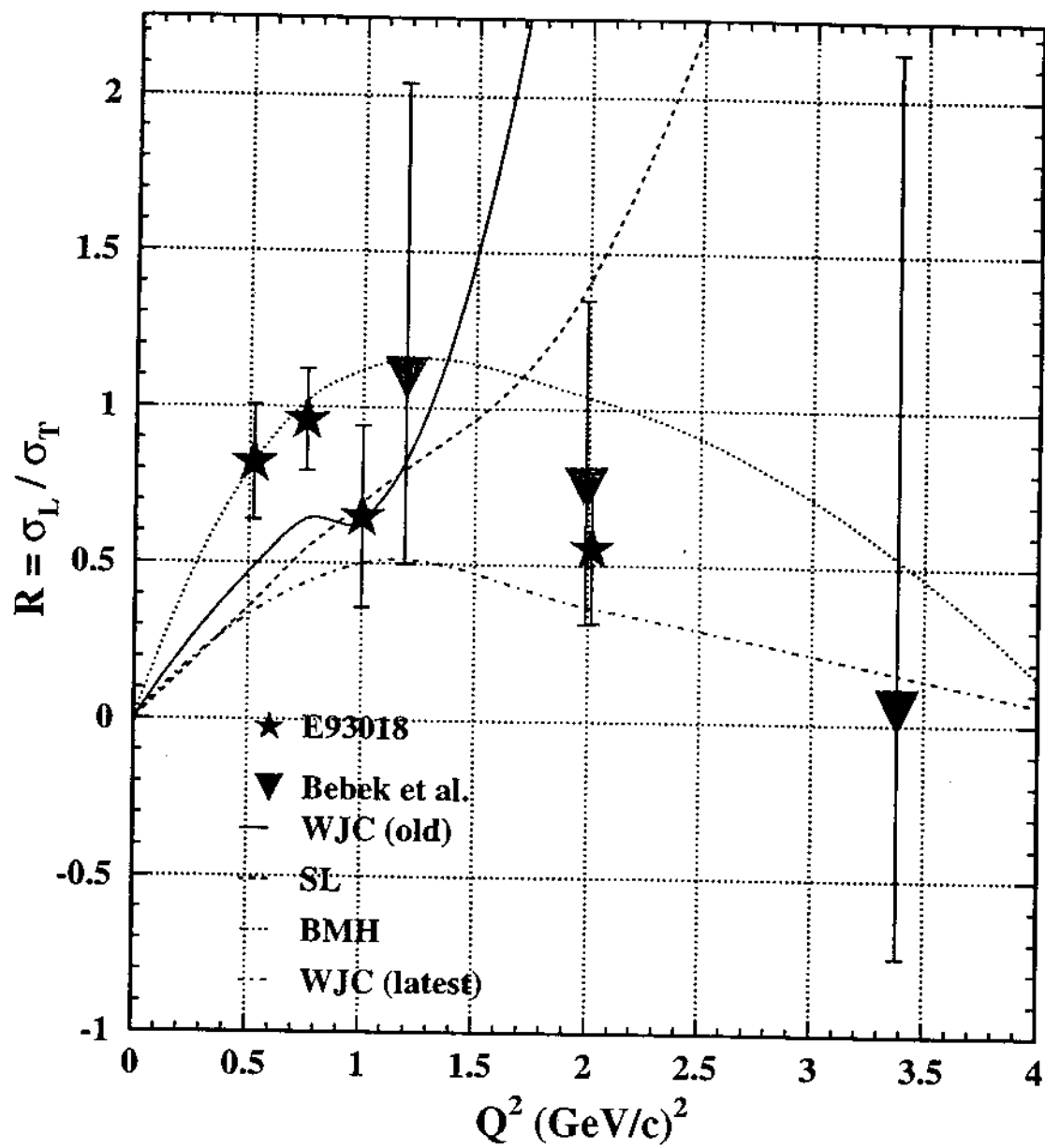
– which meet together every 3 months

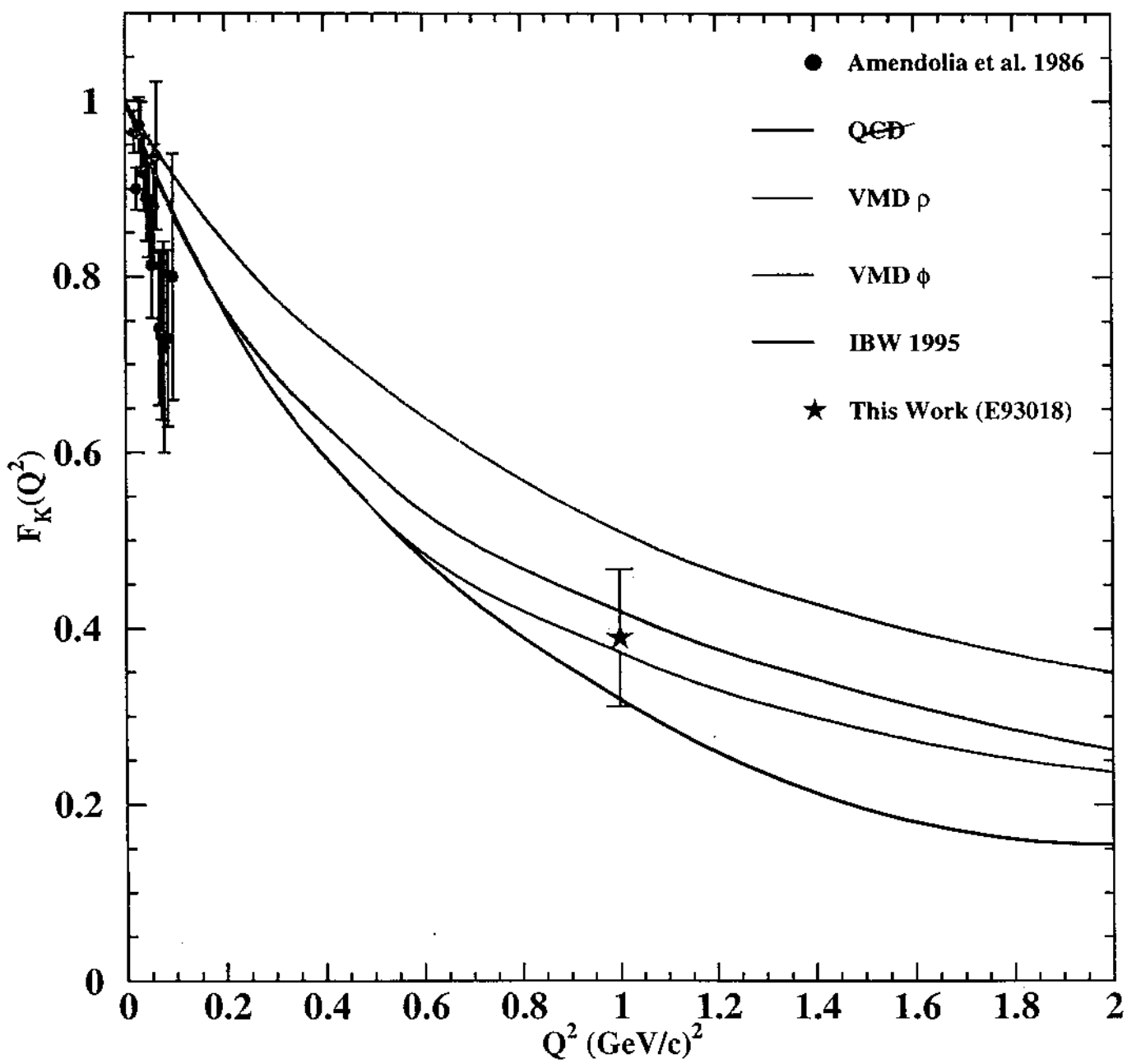
- Physics (mostly Users) – during calendar 2000 develop physics program for ~6GeV beam using SHMS-Lite + HMS.
 - Develop of scale 3 outstanding proposals
- Detector (Users + Jlab) – define and obtain commitments from user community to build the detector package components.
 - New components
 - Explore recycling SOS systems
- Optics (mostly Jlab) – during calendar 2000 develop technical proposal for a SHMS-Lite which is straightforwardly upgradable to ~12GeV via a new superconducting dipole.
 - Support structure & shield house
 - 2 “slim width” HMS style Q_1 quads.
 - Use 1 “surplus” resistive dipole (SLAC ESA 20GeV dipole or equiv.)
- **Early Calendar 2001** – submit proposals and technical design to Jlab management & PAC.

STRANGENESS AND HYPERNUCLEAR PROGRAMS AT TJNAF HALL C

- E91-016, "Electroproduction of Kaons and Light Hypernuclei", B. Zeidman, completed
- E93-018, "Kaon Electroproduction via $p(e,e'K^+)\gamma$ Reaction", O.K. Baker, completed
- E89-009, "Investigation of the Spin Dependence of the Effective ΛN Interaction in p Shell", Ed. V Hungerford, R. Chrien, L. Tang, scheduled
- E95-002, "Direct Measurement of the Lifetime of Heavy Hypernuclei at CEBAF", L. Tang and A. Margaryan, approved
- E97-008, "Spectroscopic Study of Λ Hypernuclei beyond the p-shell Region through the $(e,e'K^+)$ Reaction", O. Hashimoto, R. Sawafuta, L. Tang, conditionally approved

σ_L/σ_T - ratio





A Letter of Intent to the Thomas Jefferson National Accelerator Facility

Search for new physics at the TeV scale via a measurement of the proton's weak charge

R. Carlini, J.M. Finn, M.J. Ramsey-Musolf

Jefferson Laboratory, College of William and Mary, University of Connecticut

June 26, 1999

Abstract

We outline a concept for a low energy search for new physics beyond the Standard Model. The experiment calls for a precision measurement of the proton's weak charge via a measurement of the parity violation asymmetry in elastic e - p scattering at $Q^2 \simeq 0.03 \text{ (GeV/c)}^2$. The plan requires a re-configuration of the G^0 spectrometer, to be undertaken after the initially approved program is completed, to enable it to measure small-angle forwardly-scattered electrons. This proposed experiment of the semi-leptonic sector is complementary to SLAC experiment E158, which will carry out measurements in the purely leptonic sector at a similar Q^2 via parity violation in Møller scattering. The proposed measurement in the baryon sector is similar to, but has different theoretical uncertainties than, recently completed and proposed atomic parity violation experiments, which measure the weak charge of complex nuclei. A 1500 hour measurement can determine the proton's weak charge to $\sim 4\%$ statistical accuracy. This would be roughly equivalent to a 0.3% measurement of $\sin^2\theta_W$ (effective) in the absence of physics beyond the standard model.

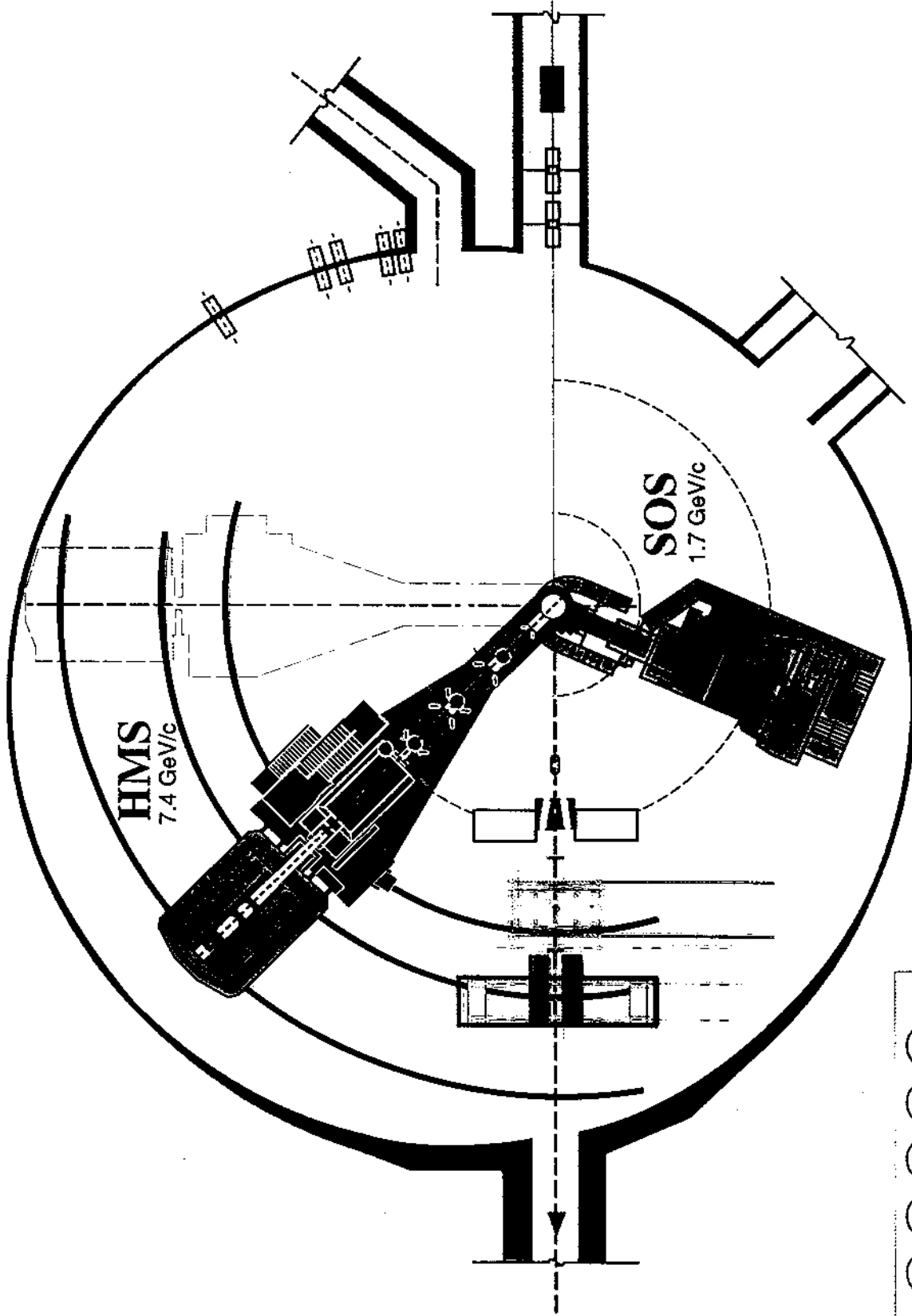
1 Introduction and Physics Motivation

The Standard Model (SM) of electroweak interactions has been confirmed with impressive precision in a variety of experiments, ranging in energies

Physics Motivation

- Low energy search for new physics beyond the Standard Model.
- Precision measurement of the weak charge of the Proton.
- Measurement in the semi-leptonic sector is complementary to the upcoming SLAC measurement.
- Roughly equivalent to a 0.3% measurement of $\sin^2\theta_w$

Hall C



Jefferson Lab

Experimental Apparatus

- Conducted after currently approved G^0 program.
- Requires reconfiguration of G^0 apparatus ~1M\$ (WAG).
 - Rework of magnet to allow through particle trajectories.
 - 1 new end cap.
 - Rework electrical/cryo plumbing (likely)
 - New detector system (simple integrating?)
 - Relocate target system upstream.

Experimental Technique

- e-p parity violation (7 - 9° lab scattering angle)
 - ~1500 hour experiment @ at $Q^2 = .03 \text{ (GeV/c)}^2$
 - Low Q^2 turns off strange Quark effects
 - Highly interpretable results (M. Musolf)
- High precision required.
 - Need a 4% statistical measurement of an already small asymmetry $\langle A \rangle = 0.28 \text{ ppm}$.
 - CEBAF's excellent beam stability may actually make this feasible.

Source of error	% Contribution to $\delta A/A$
Statistics	4
Hadronic structure	3
Polarimetry	2
Others(background, kinematics)	2
Total	5.7%

Table 1: Error budget goals in measured asymmetry.

To achieve the desired Q^2 we plan to move the G^0 target approximately 5 meters upstream and run with a one pass energy of $1.1 - 1.5 \text{ GeV}$, depending on the nominal per-pass beam energy available at the time the experiment runs. Because the input solid angle of the spectrometer increases with scattering angle, while the cross section decreases, we found that the figure of merit at constant Q^2 was nearly constant over the range of energies explored. Table 2 shows a typical kinematics setup assuming a single pass energy of 1.165 GeV and $\langle Q^2 \rangle = 0.3 (\text{GeV}/c)^2$.

Parameter	Value
Incident beam energy	$E_0 = 1.165 \text{ GeV}$
Fraction of maximum field strength	73%
Beam Helicity	80%
Beam current	$100 \mu A$
target thickness	$30 \text{ cm (LH}_2\text{)}$
Nominal scattering angle	$\theta_e = 9^\circ$
Target offset (upstream)	$Z_0 = 4.75 \text{ M}$
Theta acceptance	$\pm 1.5^\circ$
Phi acceptance	70% of 2π
Solid angle	$\Delta\Omega = 36 \text{ mstr}$
Acceptance averaged Q^2	$\langle Q^2 \rangle = 0.3$
Acceptance averaged Asymmetry	$\langle A \rangle = 0.28 \text{ ppm}$
Average cross section	$\langle \frac{d\sigma}{d\Omega} \rangle = 0.0082 \text{ fm}^{-2}$
Mean E_0 (target center)	1.161 GeV
Integrated rate ($\sum_{\text{all sectors}}$)	2.3 GHz
Running Time (100% eff.)	1500 hours
Statistical error	4%

Table 2: Typical kinematics setup. Rates are based on an acceptance averaged Monte Carlo calculation with internal and external bremsstrahlung included.

Summary

- Possible new physics initiative for Jlab parity researchers.
- Idea at the draft letter of intent stage.
- Like to get G^0 collaboration, HAPPEX and ideally a high energy group involved.

A Letter of Intent to the Thomas Jefferson National Accelerator Facility

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1 Introduction and Physics Motivation

The Standard Model (SM) of electroweak interactions has been confirmed with impressive precision in a variety of experiments, ranging in energies

from the eV scale in atomic parity violation (APV) to a few hundred GeV in e^+e^- collisions at LEP and the SLC. Consequently, the attention of the particle physics community has turned from testing the SM and measuring its parameters to searching for possible physics which may lie beyond the SM. In addition for Higgs boson searches, the search for signatures of such “new physics” is one of the primary objectives of present and future high-energy collider experiments. From a theoretical standpoint, there exist strong reasons to believe that the SM is only a “low-energy” effective theory of some larger framework. These reasons include the large number of parameters (masses, mixing angles, couplings) which must be put into the SM by hand rather than following as natural consequences of the theory; the mass hierarchy problem; and the apparent lack of coupling unification when the SM couplings are run perturbatively up to the expected grand unification scale. In addition, the SM does not explain why discrete symmetries such as parity and CP are violated; it simply incorporates these phenomenological observations into the structure of the model. One expects that a more complete theory will deeper explanations for these features of the SM and address the SM’s conceptual open questions.

Remarkably, low-energy experiments continue to play an important role in the search for this more complete theory. Experiments at the Z -pole are sensitive to new physics – such as modifications of the SM vector boson propagators – which affect physics at $t \approx M_Z^2$. Low-energy electroweak observables, on the other hand, are sensitive to new physics which does not sit on the Z -resonance, such as a Z' boson with $M_{Z'} \neq M_Z$. In particular, experiments in APV have reached sub one-percent experimental precision, making them sensitive to new physics associated with mass scales in the TeV range. These experiments measure the “weak charge” of the nucleus, $Q_W(Z, N)$, which constitutes the $Q^2 = 0$ vector coupling of the Z^0 to the nucleus. The weak charge can be computed precisely within the SM, and any measured deviation from the SM value would signal the presence of new physics. Recently, the Boulder group has reported a measurement of Q_W for ^{133}Cs which deviates from the SM prediction by 2.5σ , where the largest component of the quoted uncertainty is from atomic theory [1].

In the present experiment, we propose to measure the weak charge of the proton, Q_W^p , with parity-violating (PV) ep scattering at $Q^2 = 0.03 (\text{GeV}/c)^2$. In contrast to the $Q_W(Z, N)$ for a heavy atom, which is a large number of order N , Q_W^p is fortuitously suppressed in the SM, making it particularly sensitive to deviations arising from new physics. Consequently, the required

experimental precision is about an order of magnitude less stringent than needed for APV new physics searches. Roughly speaking, a 13% measurement of Q_W^p is equivalent in new physics sensitivity to a one percent measurement of $Q_W(Z, N)$. Moreover, the PV ep asymmetry, $A_{LR}(^1\text{H})$, is sufficiently free from theoretical uncertainties at low- Q^2 to make it interpretable as a new physics probe. We propose a better than 6% statistical plus systematic error determination of Q_W^p , with the largest theoretical uncertainty entering the SM calculation of Q_W^p is of the order of 3% [2].

We emphasize that the theoretical clarity of $A_{LR}(^1\text{H})$ is non-trivial. In the case of cesium APV, the quoted atomic theory uncertainty is nearly twice as large as the experimental error. As a way of circumventing the former, several groups are planning measurements of APV observables for atoms along an isotope chain. To a significant extent, the atomic wavefunction dependence cancels from the isotope ratios. What remains is a linear combination of Q_W^p (the dependence on the neutron's weak charge cancels out to first order) and shifts in $\rho_n(r)$, the neutron density, along the isotope chain [3]. Given the present level of knowledge of $\rho_n(r)$, any APV isotope ratio measurement must be considered a measurement of $\rho_n(r)$ isotope shifts rather than of Q_W^p . In contrast, the dominant many-body effects which enter $A_{LR}(^1\text{H})$ arise via effective nucleon form factors (see below), which can be separated from the Q_W^p term kinematically and measured. The present program of elastic $e-p$ PV experiments at the Jefferson Laboratory[4, 6, 5] and Mainz[7] will provide sufficient information on the form factor term to make the associated uncertainty acceptably small for our proposed measurement.

Measurements of both Q_W^p and $Q_W(Z, N)$ are important for identifying the type of new physics which may appear at low-energies. Whereas $Q_W(Z, N)$ depends on a nearly isoscalar combination of possible new semi-leptonic interactions involving u - and d -quarks, Q_W^p is twice as sensitive to new u -quark interactions as it is to new d -quark physics. Since there exist a variety of scenarios which imply different isospin content for possible new physics [3], the combination of both low-energy PV measurements would provide powerful constraints on new physics model building. Moreover, some new physics scenarios imply large effects in both the semi-leptonic and purely leptonic sectors, while others – such as $B - L$ violating supersymmetry – heavily favor the semi-leptonic sector [3]. The PV Møller experiment E158 planned at SLAC [8] will, together with the APV measurement of $Q_W(Z, N)$ and our proposed Q_W^p measurement, allow one to distinguish among leptonic and semi-leptonic effects. In short, our proposed measurement rounds out a

triad of parity violation measurements which will constitute one of the most powerful low-energy probes of new physics at the TeV scale.

To achieve the required statistical precision in an acceptable amount of running time, we propose to modify the G^0 spectrometer to measure small angle electrons by moving the target upstream and by building radiation hardened Čerenkov detectors capable of withstanding the estimated $\sim 2.3\text{GHz}$ counting rate. At these rates integration of the signal is required, as is done in the HAPPEX experiment at JLab and is planned for E158 at SLAC. The most difficult challenge will be to measure the approximately 0.3ppm asymmetry to about 4% statistical accuracy. Still this is no more difficult than what is being attempted at SLAC and the helicity-correlated errors should be more easily controllable using the Continuous Electron Beam Facility of Jefferson Laboratory.

2 Theoretical Interpretability

The PV ep scattering asymmetry has the general structure[9]

$$A_{LR} = a_0 \tau [Q_W^p + F^p(q)] \quad , \quad (1)$$

where $a_0 = 3.1 \times 10^{-4}$. The first term contains the τ -independent proton weak charge, while the second depends on a combination of hadronic form factors. At tree level, one has

$$F^p(\tau) = - \left[G_E^p (G_E^n + G_E^{(s)}) + \tau G_M^p (G_M^n + G_M^{(s)}) \right] / [(G_E^p)^2 + \tau (G_M^p)^2] \quad , \quad (2)$$

where G_E^p , G_E^n , G_M^p , G_M^n are the neutron and proton electromagnetic Sachs form factors and $G_E^{(s)}$ and $G_M^{(s)}$ are the nucleon strangeness electric and magnetic form factors. Here we make the forward angle approximation, where the longitudinal polarization, $\varepsilon(\theta) \rightarrow 1$. Since both G_E^n and $G_E^{(s)}$ vanish at $\tau = 0$, we may write

$$F^p(\tau) = \tau B(\tau) \quad . \quad (3)$$

It is also useful to write

$$B(\tau) = B_0(\tau) + \delta B(\tau) \quad , \quad (4)$$

where $B_0(\tau)$ gives the contribution arising from the neutron and proton EM form factors and $\delta B(\tau)$ contains deviations generated by $G_E^{(s)}$, $G_M^{(s)}$; higher-order electroweak radiative corrections as discussed below; and uncertainties in the nucleon EM form factors.

The τ -dependence of Eq. (3) provides for a kinematic separation of the form factor term from the weak charge term in Eq. (1). By measuring A_{LR} at somewhat higher τ than proposed for this experiment, one can constrain $\delta B/B_0$ to be sufficiently small at lower τ . For the kinematics of this experiment, we require $\delta B/B_0 < 0.115$ ($\tau = 0.008$). The published HAPPEX results yield $\delta B/B_0 < 0.196$ at $\tau = 0.14$ [12]. The proposed second phase of HAPPEX aims at $\delta B/B_0 \lesssim 0.1$ at $\tau = 0.027$. [5] The Mainz experiment is expected to achieve $\delta B/B_0 \lesssim 0.06$ and $\tau = 0.07$. [7] When combined with the expected G^0 measurements [6] of F^p over a range of τ , these measurements will provide for a smooth extrapolation of $F^p(\tau)$ to $\tau = 0.008$ with acceptably small uncertainty.

The remaining theoretical uncertainties are those which enter Q_W^p itself. Of these, the largest appear to be hadronic contributions to the $Z - \gamma$ mixing tensor, which have been estimated to give a 3% uncertainty in Q_W^p [2]. Additional hadronic effects arise via box graphs, or “dispersion corrections”, containing one or more photons. The effects of two-photon dispersion corrections vanish as $Q^2 \rightarrow 0$, and so can be included in the quantity $B(\tau)$ [3]. Measurements of $F^p(\tau)$ in the present PV program will, therefore, constrain uncertainties associated with these $\gamma - \gamma$ dispersion corrections to be smaller than needed for a 5% determination of Q_W^p . The remaining τ -independent dispersion correction arises from box diagrams containing one γ and one Z -boson. These corrections are proportional to the tree-level value for Q_W^p , and so enter as an $\mathcal{O}(\alpha/4\pi)$ correction [3, 10, 11]. Hadronic uncertainties associated with this correction are, therefore, expected to be well below the 5% level.

3 Brief Description of the Apparatus

A 3-dimensional view of the G^0 spectrometer is shown in Figure 1.

We are currently studying what modifications will be required to the current G^0 apparatus to allow the proposed measurement to be performed in Hall C. The spectrometer has 8-superconducting coils laid out in a toroidal geometry. A cross section of the G^0 coil layout is shown in Figure 2. In

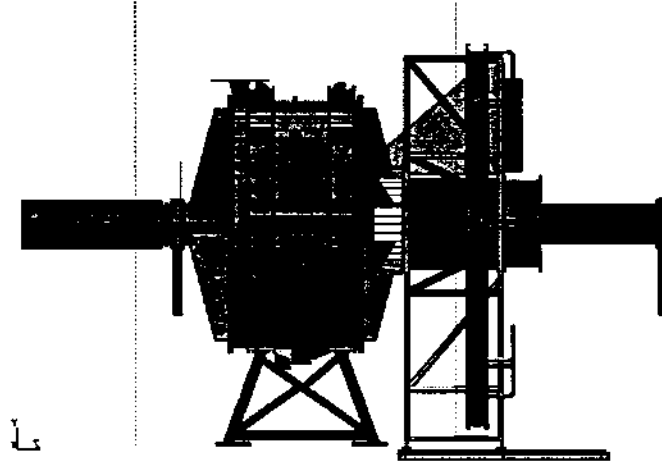


Figure 1: A view of the G^0 spectrometer.

its current configuration the target is located within the magnet along its central axis. The G^0 core experimental equipment consists basically of the superconducting magnet, a retractable detector assembly, a beam monitoring instrumentation girder, and a 20 cm cryotarget assembly. The proposed measurement would make use of all these existing systems with the exception of the present detector assembly. We would replace the detector with a simple ring of plastic Čerenkov detectors, read out in a purely analog manner via vacuum photodiodes.

The proposed layout is shown in Figure 3. The target assembly is now located outside and upstream of the magnet thus allowing for the detection of $\sim 7 \pm 1.17^\circ$ elastic $e-p$ events. The target length has been increased from 20 cm to 30 cm, as called off in the original design specifications (Physics requirements constrain the current configuration) The magnet will require some rework to allow particles to enter from the front of the assembly. This rework includes: a new upstream flange with windows, similar in mechanical construction to the existing downstream windowed flange, the removal of the G^0 internal collimators, and some of the internal interconnecting plumbing and buss bars will need to be rerouted to allow for an unobstructed particle

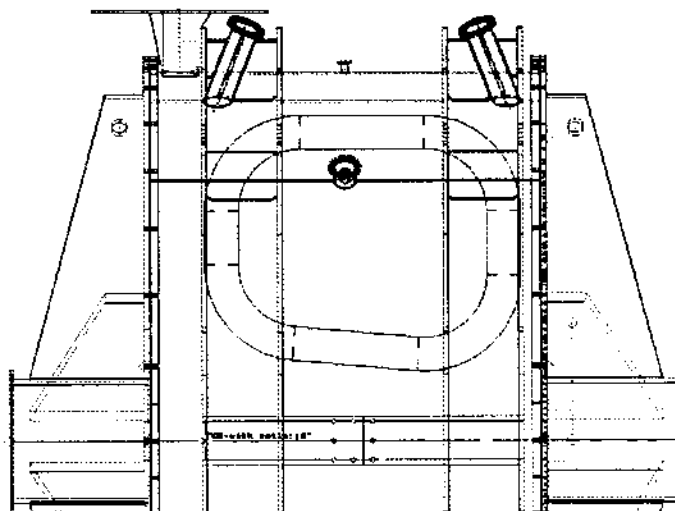


Figure 2: Section of G^0 8-sector toroidal spectrometer showing coil geometry

entrance. Since the target is now relatively far upstream, it is a straightforward task to insert sculptured non-magnetic shielding between the target and magnet to shadow shield the detectors.

A TOSCA analysis using a realistic coil geometry was used to carry out raytracing of elastic events through the spectrometer. Shown in Figure 4 is the clean separation of the elastic e-p events from the inelastic threshold rays in the bend plane. (Figure 5 shows that there is very little transverse focusing or de-focusing.) Therefore, we anticipate that the new detector system will behave similar to the HAPPEX detectors with the improvement that vacuum photodiodes plus an amplifier will be employed. This system has the advantage of having no pulse heights variations like PMT's and has been used successfully on parity experiments at Los Alamos where extremely small asymmetries ($\sim 10^{-8}$) measurements were desired. Approximately 480 1-inch vacuum photodiodes might be employed. Each of the 8 sectors (~ 60 diodes each) would be electrically summed, input to a high gain ultra-linear op amp I-to-V (current to voltage converter), fed into a linear V/F converter, and finally digitized by scalars. The proposed helicity reversal rate would be 30Hz and the experiment readout rate would be 120Hz . The 120Hz rate is

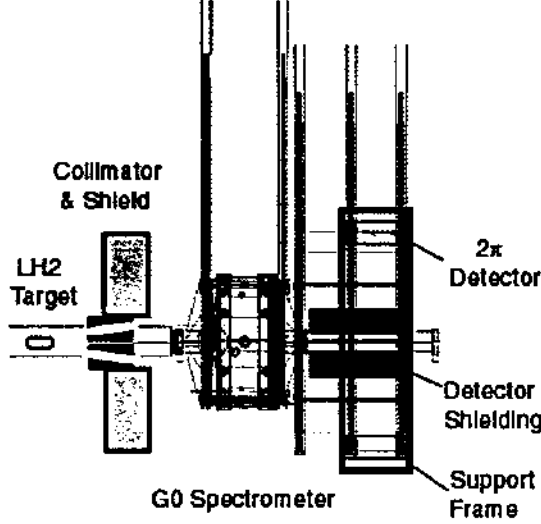


Figure 3: *Proposed re-configuration of G^0 spectrometer for detection of elastic scattering of electrons at forward angles.*

to allow for a $4\times$ over-sampling rejection of non-linear induced systematics from $60Hz$ line couplings and prevent the leakage of the reversal signal into the apparatus. None of the proposed detector technologies are either new or complex, but are straightforward and have been proven to work extremely well.

4 Kinematics and Rate Estimates

To optimize the figure of merit, we modified the HAPPEX Monte Carlo[13] to incorporate the geometry of the G^0 spectrometer. The Monte Carlo presently includes weak radiative corrections and nuclear Bremsstrahlung (the latter in the effective radiator approximation). Finite target and acceptance effects were also included. At present we assume a geometrically constrained solid angle. For a believable test of the Standard Model, the uncertainty in the nuclear structure should be no larger than the statistical error of the measurement. For forward angles the axial vector contribution to the asymmetry is small. At sufficiently low Q^2 , one can expand the remaining terms

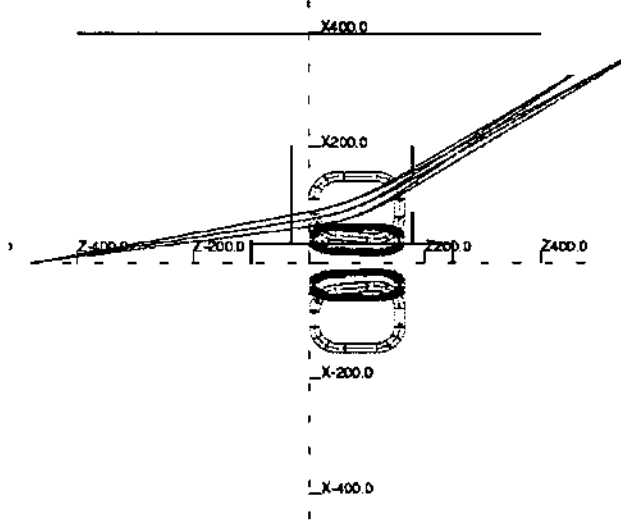


Figure 4: Raytrace of elastic scattered events for $E_0 = 1.15 \text{ GeV}$, $\theta_e = 9 \pm 1.5^\circ$, and $\varphi_e = 0^\circ$ (symmetry midplane) showing pt-pt focusing in the bend plane. The second set of rays with greater curvature represents the kinematic limit for inelastic scattering events.

the parity violating asymmetry in powers of $\tau = Q^2/4m_p^2$:

$$A = a_0 \tau [Q_W^p + \tau \rho_{eff}] , \quad (5)$$

where $\rho_{eff} = B(0)$ is the leading term in the nuclear structure which can be expanded in terms of neutron and strange quark charge radii and magnetic moments:

$$\begin{aligned} \rho_{eff} &= \varepsilon(\theta)(\rho_n + \rho_s) + \mu_p(\mu_n + \mu_s) , \\ \rho_{n,s} &= \frac{\partial G_{n,s}}{\partial \tau} \Big|_{\tau \rightarrow 0} . \end{aligned} \quad (6)$$

At very low Q^2 the terms sensitive to nuclear structure turn off. A measurement of 6% (combined statistical and systematic error) is sufficient to extract

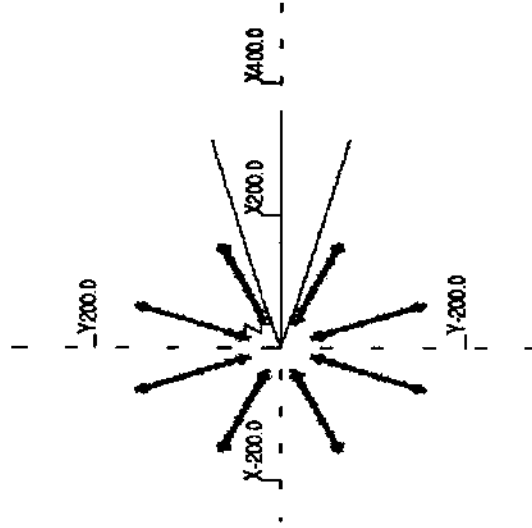


Figure 5: *Projection of elastic scattering trajectories into the (ρ, ϕ) plane perpendicular to the cylindrical axis for $E_0 = 1.15 \text{ GeV}$, $\theta_e = 9^\circ$, and $\varphi_e = 0, \pm 15^\circ$. Rays begin at the target origin ($\rho = 0 \text{ M}$, $z = -4.75 \text{ M}$) and exit the magnet at $z \simeq 1.5 \text{ M}$ downstream moving along lines of nearly constant φ . There is very little transverse focusing.*

Q_W^P to the desired accuracy. Therefore the beam polarization accuracy is not very demanding. A 2% measurement appears to be achievable using the Hall C Møller Polarimeter. It would be highly desirable to complement this device with a Compton polarimeter, giving a continuous non-destructive measurement of the beam polarization.

This error is dominated by the unknown strange quark content of the nucleon. However, proposed measurements by the HAPPEX and G^0 Collaborations should reduce the uncertainty in $\delta\rho_{eff}$ to < 0.35 . This assumption then fixes the maximum Q^2 of the measurement to about $0.03(\text{GeV}/c)^2$. Table 1 shows the anticipated error budget goals for the proposed experiment.

Source of error	% Contribution to $\delta A/A$
Statistics	4
Hadronic structure	3
Polarimetry	2
Others(background, kinematics)	2
Total	5.7%

Table 1: Error budget goals in measured asymmetry.

To achieve the desired Q^2 we plan to move the G^0 target approximately 5 meters upstream and run with a one pass energy of $1.1 - 1.5 \text{ GeV}$, depending on the nominal per-pass beam energy available at the time the experiment runs. Because the input solid angle of the spectrometer increases with scattering angle, while the cross section decreases, we found that the figure of merit at constant Q^2 was nearly constant over the range of energies explored. Table 2 shows a typical kinematics setup assuming a single pass energy of 1.165 GeV and $\langle Q^2 \rangle = 0.3 (\text{GeV}/c)^2$.

Parameter	Value
Incident beam energy	$E_0 = 1.165 \text{ GeV}$
Fraction of maximum field strength	73%
Beam Helicity	80%
Beam current	$100 \mu A$
target thickness	$30 \text{ cm } (LH_2)$
Nominal scattering angle	$\theta_e = 9^\circ$
Target offset (upstream)	$Z_0 = 4.75 \text{ M}$
Theta acceptance	$\pm 1.5^\circ$
Phi acceptance	70% of 2π
Solid angle	$\Delta\Omega = 36 \text{ mstr}$
Acceptance averaged Q^2	$\langle Q^2 \rangle = 0.3$
Acceptance averaged Asymmetry	$\langle A \rangle = 0.28 \text{ ppm}$
Average cross section	$\langle \frac{d\sigma}{d\Omega} \rangle = 0.0082 \text{ fm}^{-2}$
Mean E_0 (target center)	1.161 GeV
Integrated rate ($\sum_{\text{all sectors}}$)	2.3 GHz
Running Time (100% eff.)	1500 hours
Statistical error	4%

Table 2: Typical kinematics setup. Rates are based on an acceptance averaged Monte Carlo calculation with internal and external bremsstrahlung included.

Based on these kinematic assumptions a 4% statistical measurement could be carried out in 0.15 amp-hrs (540 C), *i. e.*, 1500 hours of 100 μ A beam, running at 100% efficiency. This would be roughly equivalent to a 0.3% measurement of $\sin^2 \theta_W$ (effective) in atomic PV experiments.

5 Summary

Further improvement of source systematics will be needed to demonstrate adequate control of helicity dependent correlations using the stressed-GaAs source. However, the first HAPPEX run using the bulk GaAs source has already demonstrated that the required beam stabilities are within reach at Jefferson Laboratory.[12] The proposed re-configuration of the G^0 spectrometer is straight-forward and cost effective compared to construction of a new dedicated spectrometer. We envision running this experiment after the currently approved G^0 program is completed, giving adequate time for the design and fabrication stages needed to implement the concept we have outlined here. We plan to approach members of the current HAPPEX and G^0 Collaborations to solicit their contribution to this effort and are also interested in seeing if an additional high energy group or two can be attracted to this project. We believe the physics goals to be achievable and highly meritorious of consideration by the Jefferson Laboratory physics community and management.

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